140A

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

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140A

OPERATING AND SERVICE MANUAL

MODEL 140A

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Table 1-1. Specifications

PLUG-IN COMPARTMENTS

Upper Compartment, horizontal axis:
Accepts horizontal plug-ins, Models 1420 to 1424 or, if desired, amplifier plug-ins, Models 1400 to 1414. Plug-in operates directly into horizontal deflection plates in Model 140A.

Lower Compartment, vertical axis:
Accepts plug-in amplifiers, Models 1400 to 1414 or, if desired, horizontal plug-ins, Models 1420 to 1424. Plug-in operates directly into vertical deflection plates in Model 140A.

Combined:
Dividing shield can be removed; compartment accepts single large plug-in units. Models 1415 to 1419.

CATHODE-RAY TUBE

Type:
hp post-accelerator, 7.5-kv accelerating potential, aluminized P31 phosphor standard; for other phosphors, see OPTIONS.

Graticule:
10 x 10 cm parallax-free internal graticule, marked in centimeter squares; subdivisions of 2 mm on major horizontal and vertical axes.

Intensity Modulation:
Approximately +20 volt pulse will blank trace of normal intensity; terminals on rear panel.

CALIBRATOR

Type:
Line-frequency rectangular signal, approximately 0.5 μsec rise time.

Voltage:
Two outputs: 1 volt and 10 volts peak-to-peak, ±1% from 15°C to 35°C, ±3% 0°C to 55°C.

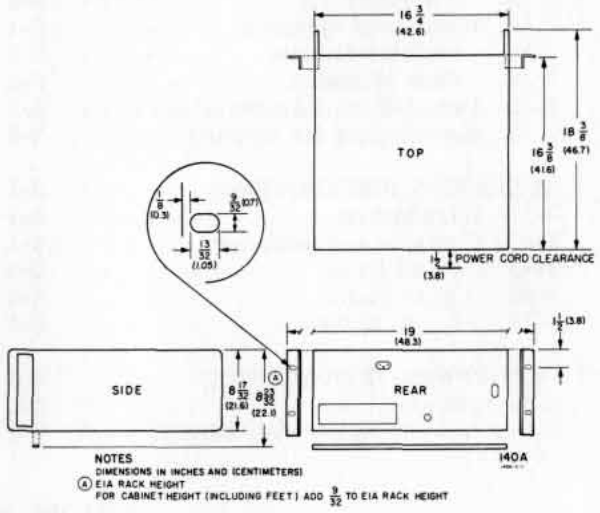
BEAM FINDER

Pressing BEAM FINDER control brings trace on screen, regardless of setting of horizontal or vertical POSITION control.

GENERAL

Power Requirements:
115 or 230 volts ±10% AC, 50 to 60 cps, normally less than 285 watts (varies with plug-in used). Will provide 140 watts of regulated power to plug-ins.

Dimensions:



Weight:
37 lb net without plug-ins

Options:
02. CRT with internal graticule and P2 phosphor installed
07. CRT with internal graticule and P7 phosphor installed
11. CRT with internal graticule and P11 phosphor installed

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SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The hp Model 140A (Figure 1-1) is a general purpose plug-in oscilloscope. The deflection amplifiers are contained within the plug-in units, which operate directly into the cathode-ray tube. Thus the characteristics of the oscilloscope are dependent upon the plug-ins used. Presently available plug-ins make possible high-sensitivity, wide bandwidth, and single, dual, or four-trace measurements, in combination with normal, single, or delayed sweeps. Double-size plug-ins also are available for special applications such as time domain reflectometry.

1-3. The Model 140A provides power for the plug-ins, as well as line-frequency square-wave calibrating voltages of 10 volts and 1 volt peak-to-peak, which are available on the front panel of the Model 140A. The primary power switch and all CRT controls are on the Model 140A front panel, and the terminals and switch for Z-axis modulation are on the rear panel.

1-4. The Model 140A uses an internal graticule CRT which eliminates parallax error in observing the display. The CRT is equipped with a nonglare safety face plate.

1-5. OPTIONS.

1-6. The Model 140A normally is supplied with a type P31 aluminized phosphor CRT. The following options, however, are available:

a. Option 02. P2 phosphor (general purpose)
b. Option 07. P7 phosphor (long persistence)
c. Option 11. P11 phosphor (fast writing rate)

1-7. ASSOCIATED EQUIPMENT.

1-8. Some of the plug-ins available for the Model 140A Oscilloscope are listed in Table 1-2. The Model 140A normally is used with an amplifier plug-in in the lower compartment and a sweep plug-in in the upper compartment. The plug-in in the lower compartment produces vertical deflection, and the plug-in in the upper compartment produces horizontal deflection. All hp Model 1400-series plug-ins can be used with the Model 140A Oscilloscope. Plug-in model numbers are grouped according to function:

Models 1400 to 1414 . . . . . Plug-ins normally used for vertical deflection
Models 1415 to 1419 . . . . . Double or full sized plug-ins
Models 1420 to 1424 . . . . . Plug-ins normally used for horizontal deflection

Figure 1-1. Model 140A Oscilloscope with Model 1400A Amplifier and Model 1420A Time Base Plug-In Units

Table 1-2. Plug-Ins for Model 140A Oscilloscope *

Model	Name	Description
1400A	Differential Amplifier	100 μv/cm to 20 v/cm sensitivity; DC to 400 kc bandwidth
1401A	Dual Trace Amplifier	Dual trace and differential display; 1 mv/cm to 10 v/cm sensitivity; DC to 450 kc bandwidth
1402A	Dual Trace Amplifier	Dual trace and differential display; 5 mv/cm to 10 v/cm sensitivity; DC to 20 Mc bandwidth
1403A	AC Differential Amplifier	10 μv/cm to 0.1 v/cm sensitivity; 0.1 cps to 400 kc bandwidth; variable bandwidth limits
1415A	Time Domain Reflectometer	Double-sized plug-in for time domain reflectometry. Includes pulse generator, vertical sampling, and time base functions. System risetime less than 0.1 nanosecond; reflection coefficients of .001 can be observed.
1420A	Time Base	Sweep ranges from 0.5 μsec/cm to 5 sec/cm; X10 magnifier expands fastest sweep to 50 nsec/cm. Single sweep and external horizontal input functions provided. Internal or external triggering to greater than 10 Mc.
1421A	Time Base and Delay Generator	Both Normal and Delaying sweeps from 0.1 μsec/cm to 1 sec/cm; X5 magnifier expands fastest sweep to 20 nsec/cm; internal or external triggering to greater than 20 Mc. Delay time continuously variable from 0.1 μsec to 10 sec. Delay functions: Normal sweep; Mixed sweep; Intensified: triggered or armed; Delayed: triggered or armed.

* Check latest literature for additional new plug-ins.

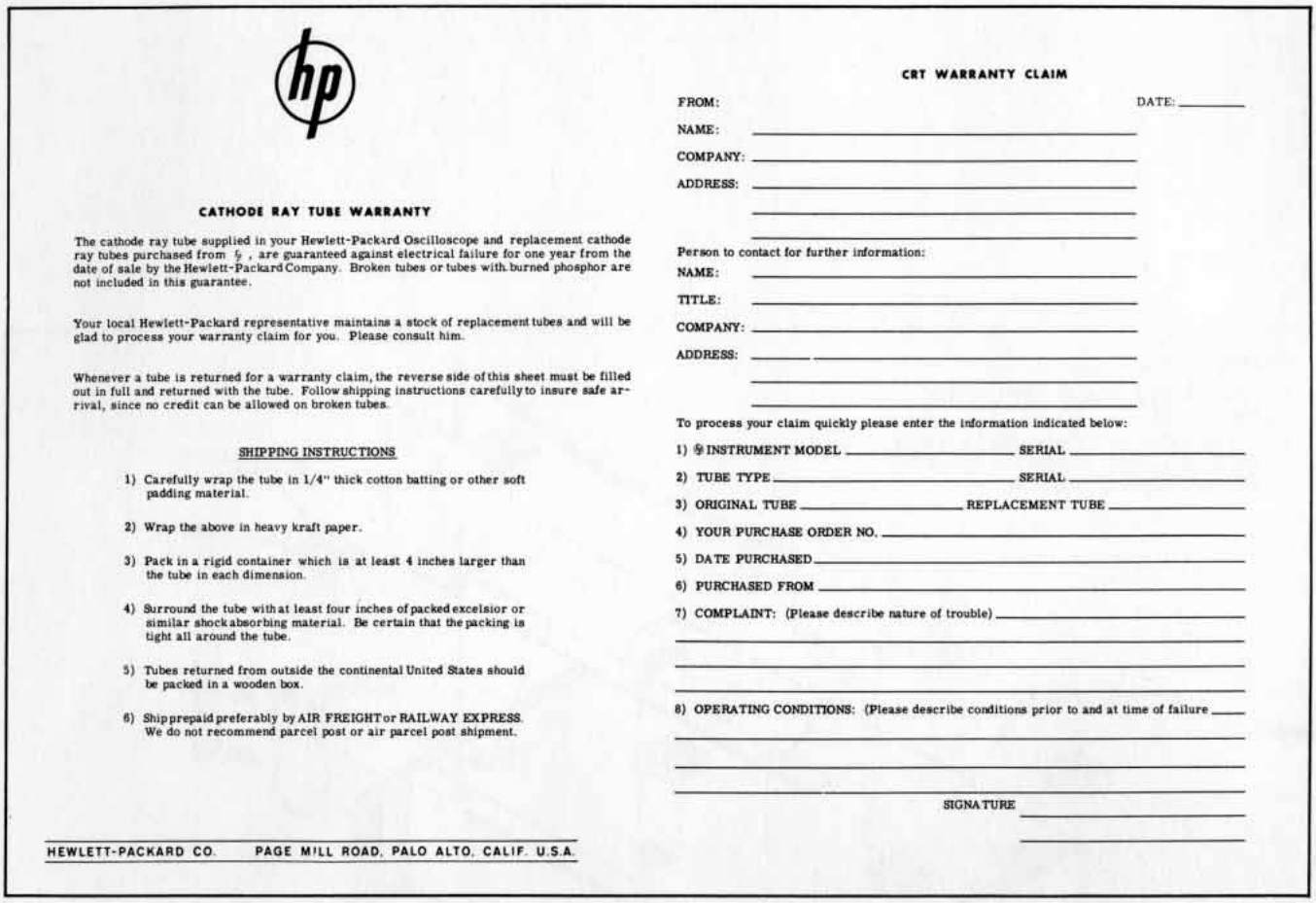
1-9. Arrangements of plug-ins can be chosen to suit any special application. Amplifier and sweep plug-ins can be reversed so that the amplifier produces horizontal deflection and the sweep runs vertically. (When used this way the beam will not be blanked on the sweep retrace.) An amplifier plug-in can be used in each compartment to make X-Y measurements. Double sized plug-ins, such as the Model 1415A, are inserted into the oscilloscope after removing the divider shield between upper and lower compartments.

1-10. INSTRUMENT IDENTIFICATION.

1-11. The Model 140A carries an eight digit serial number (000-00000). When the serial-prefixed number on the title page of the manual is the same as the first three digits of the instrument serial number, the manual applies directly to the instrument; when these numbers differ, change sheets supplied with the manual will specify changes required to make this manual apply directly to the instrument.

1-12. CATHODE-RAY TUBE WARRANTY.

1-13. The cathode-ray tube supplied with the Model 140A is guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. The cathode-ray tube warranty is illustrated in Figure 1-2. A warranty sheet for your use is included in the appendix of this manual.



CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from hp, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.

2) Wrap the above in heavy kraft paper.

3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

HEWLETT-PACKARD CO. PAGE MILL ROAD, PALO ALTO, CALIF. U.S.A.

CRT WARRANTY CLAIM

FROM: DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

_____

_____

To process your claim quickly please enter the information indicated below:

1) hp INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

_____

_____

_____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure _____

_____

_____

_____

SIGNATURE _____

_____

Figure 1-2. Cathode-Ray Tube Warranty

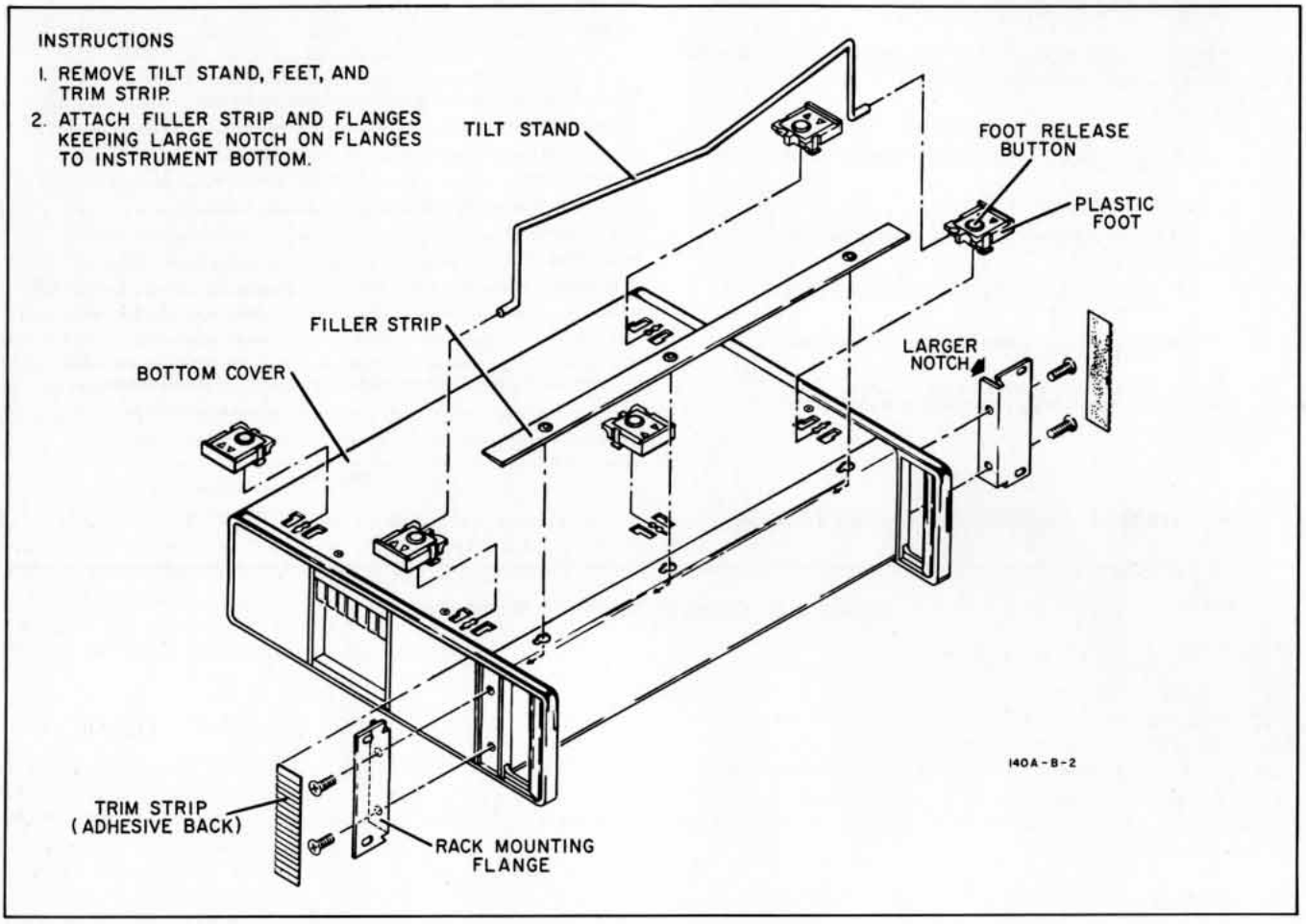


Figure 2-1. Rack Mounting Procedure

SECTION II
INSTALLATION

2-1. INCOMING INSPECTION.

2-2. MECHANICAL INSPECTION. Upon receipt of the Model 140A, check the contents of the carton and inspect the instrument for any obvious damage received in shipment. If damage is evident, file a claim with the carrier. Refer to the warranty sheet at the rear of this manual for additional information. Keep the packing material until an operational check has been completed.

2-3. OPERATIONAL CHECK. Refer to Section V (Paragraph 5-3) for a performance check to verify that operation is within published specifications. This check requires that either a single large plug-in or two small plug-ins be installed.

2-4. POWER REQUIREMENTS.

2-5. The Model 140A requires a power source of 115 or 230 volts ±10%, single phase, 50 to 60 cps, which can deliver approximately 300 watts.

CAUTION

Be sure to set the 115-230 volt switch for the line voltage to be used. The power supplies may be damaged if this switch is set to the wrong position.

2-6. 230-VOLT OPERATION.

2-7. If the instrument is to be operated from a 230-volt source, set the switch on the rear of the instrument to 230. The line fuse, located behind the rear panel, is accessible by removing the bottom cover, and should be replaced with a 2-amp slow-blow fuse (supplied). (A 4-amp slow-blow fuse is used with 115-volt operation.)

2-8. THREE CONDUCTOR POWER CABLE.

2-9. To protect operating personnel, the National Electrical Ma. :facturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail to ground.

2-10. COOLING.

2-11. VENTILATION REQUIREMENTS.

2-12. The Model 140A uses a forced-air cooling system to maintain reasonable operating temperatures within the cabinet. The air intake and filter are located on the rear of the instrument. When installing the Model 140A, choose a location that provides at least three inches of clearance around rear and sides of instrument.

2-13. AIR FILTER.

2-14. The filter should be cleaned periodically to ensure proper cooling. After cleaning, the air filter, located on the rear of the instrument, should be coated with a filter adhesive such as Filter Coat No. 3 from Research Products Co. Refer to Paragraph 5-32 for cleaning procedures.

2-15. INSTRUMENT MOUNTING.

2-16. MODULAR CABINET.

2-17. The Model 140A is shipped from the factory as a bench instrument with the tilt stand, feet, and plastic trim in place. The top and bottom cabinet covers can be removed, giving complete accessibility to all components and adjustments. Sufficient space should be allowed around the cabinet for adequate circulation air.

2-18. RACK MOUNTING.

2-19. Prepare the cabinet for rack mounting as illustrated in Figure 2-1. All necessary hardware is in the shipping carton with the instrument. After preparation, lift the instrument into place, and secure mounting flanges to rack with appropriate screws. Allow adequate ventilation for the instrument in the rack.

2-20. INSTALLATION OF AMBER FILTER.

2-21. An amber filter (hp Stock No. 120A-83A) is supplied with oscilloscopes which have a CRT with type P7 phosphor. This filter improves the visibility of displays such as single-shot or very low frequency phenomena. The filter improves the long persistency characteristics of the trace when making visual observations of this type of display. To install the filter:

a. Remove front panel CRT bezel.

b. Set filter into bezel, aligning larger rectangular slots in edge of filter with guide metal posts of bezel casting.

c. Loosen clamp at socket of CRT.

d. Carefully push CRT toward rear of the instrument to provide clearance for thickness of installed filter (about 1/8 inch).

e. Replace bezel.

f. Slide CRT forward until light mask on front of CRT just lightly touches filter.

g. Tighten clamp just enough to keep CRT from turning.

h. Check trace alignment. See Paragraph 3-7.

2-22. REPACKAGING FOR SHIPMENT.

2-23. If you find it necessary to repack the instrument, the original shipping container and packing material may be used. If these have been discarded or are not re-usable, new materials can be obtained from your Hewlett-Packard Engineering Representative. Or follow these general instructions:

a. Wrap in heavy paper or plastic.

b. Use ample packing material around all sides of the instrument. Protect the panel with cardboard strips.

c. Pack in a wooden box or heavy cardboard carton, and seal with heavy tape or metal bands.

d. Mark the box, "FRAGILE--DELICATE INSTRUMENT".

e. Insure the shipment.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 140A Oscilloscope is a plug-in oscilloscope, using a minimum number of functions on the main unit. Most of the controls are located on the plug-in units, and therefore detailed operating instructions are given in the manuals for the plug-in units. The Model 140A includes the cathode-ray tube and its associated controls, power supplies, and a calibrator which is used for vertical-sensitivity and sweep-time calibration as well as probe compensation.

3-3. CONTROLS AND INDICATORS.

3-4. FRONT PANEL.

3-5. Figure 3-1 identifies the front panel controls, indicators, and terminals, and provides a short description of their functions.

3-6. BEAM FINDER OPERATION. Frequently the CRT trace can be driven off the CRT screen by excessive DC input levels or by misadjustment of position or balance controls on the plug-ins. When the BEAM FINDER switch is depressed, the beam is confined to the screen of the CRT. If the trace is centered with the position and/or balance control when the BEAM FINDER is depressed (see manual for plug-in for specific instruction), the trace will remain on screen when the BEAM FINDER is released.

NOTE

At high amplifier sensitivities a further slight adjustment of the balance control may be necessary. Failure of the BEAM FINDER to bring the trace on screen may generally be attributed to insufficient intensity or unusually high DC signal input. It should also be noted that when single-sweep operation is used with a time base plug-in, the spot at the end of a single sweep will be blanked by termination of the gate.

3-7. TRACE ALIGN ADJUSTMENT. To compensate for slight manufacturing tolerances and external magnetic disturbances, a front panel screwdriver adjustment has been provided to align the trace with the graticule. Adjust TRACE ALIGN whenever realignment of the trace seems necessary. A check should be made after moving the instrument to a new operating location.

3-8. ASTIGMATISM ADJUSTMENT. To provide uniform focus of the trace over the display area, the ASTIGMATISM control, a front panel screwdriver adjustment, is used in conjunction with the FOCUS control. For correct adjustment, adjust both FOCUS and ASTIGMATISM for sharpest display of signal. Because different plug-ins will apply different DC potentials to the deflection plates, it will usually be necessary to readjust ASTIGMATISM whenever plug-ins are changed.

3-9. REAR PANEL.

3-10. 115/230. This switch, located at the bottom of the rear panel, must be set to the nominal line voltage before plugging the power cable into the service outlet.

3-11. Z-AXIS INPUT. The Z-AXIS INPUT terminals and selector switch are located on the rear panel of the instrument. To externally modulate the trace intensity, set the selector switch to EXT, and apply modulating signal to Z-AXIS INPUT terminals. The amplitude of modulating pulse required to blank the trace depends upon the level of beam intensity, and is about 20 volts positive for average intensities. Conversely, a negative pulse can be applied to the Z-AXIS INPUT to intensify the trace. When not using the terminals, be sure that the ground strap is in place. When the oscilloscope is used with a dual channel plug-in, the selector switch should be placed in the INT position. This will connect the chopper blanking pulse to the CRT cathode, so that switching transients will be blanked out when the plug-in is being used in the chopped mode of operation.

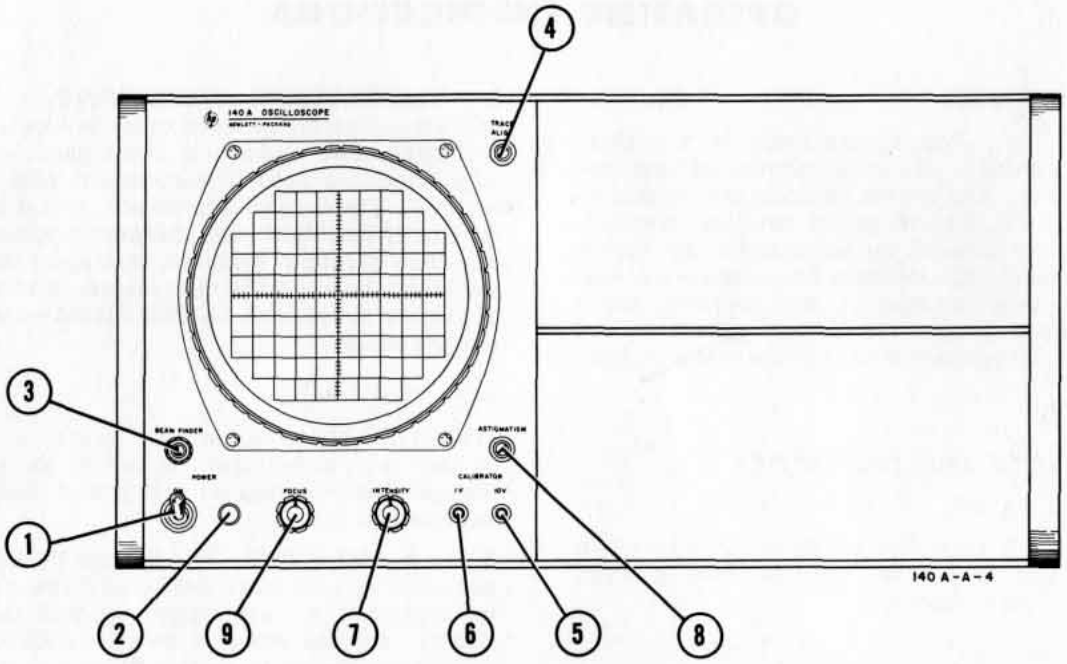
3-12. PLUG-IN UNITS.

3-13. INSTALLATION. Insert vertical amplifier (or other unit desired to produce vertical deflection) into the lower compartment, and lock in place. Insert a time base plug-in (or amplifier) into upper compartment, and lock in place. For double-sized plug-ins, remove the dividing shield, insert plug-in, and lock.

NOTE

For proper operation, make sure that the shield is in place when using standard size plug-ins.

3-14. GAIN. Because of differences in cathode-ray tube sensitivities, it will usually be necessary to readjust plug-in gain when units are interchanged or moved from one Model 140A to another.



1. Applies AC line power to the instrument.
2. Indicates that the instrument is on.
3. Returns beam to CRT screen.
4. Aligns trace with graticule.
5. 10-volt peak-to-peak calibrating signal (line frequency square wave).
6. 1-volt peak-to-peak calibrating signal (line frequency square wave).
7. Controls intensity of CRT display.
8. Controls roundness of spot.
9. Adjusts focus of trace.

Figure 3-1. Model 140A Controls

SECTION IV
PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. Figure 4-1 is a simplified block diagram of the Model 140A Oscilloscope. Three major circuits are included in the main unit of the oscilloscope: a low-voltage power supply, an amplitude-and-time calibrator, and a high-voltage power supply for the cathode-ray tube. The vertical and horizontal plug-ins are not part of the main unit, and operate directly into the CRT.

4-3. LOW-VOLTAGE POWER SUPPLY. The low-voltage power supply uses 115/230 volt single-phase power from the line, and generates the following output voltages: +250, +100, -100, and -12.6 volts DC, and 6.3 volts AC. All DC supplies are regulated. Voltages are distributed to the calibrator, the high-voltage power supply, and the vertical and horizontal plug-in units.

4-4. CALIBRATOR. The calibrator uses a 6.3-volt signal from the power transformer to drive a tunnel diode which shapes the signal to a square-wave output. Outputs of 10-volts and 1-volt (peak-to-peak amplitude) are made available on the front panel as calibrating signals accurate to ±1%. The 1-volt square wave is also applied to the plug-ins for internal use in horizontal and vertical sensitivity calibration.

4-5. HIGH-VOLTAGE POWER SUPPLY. A transistorized oscillator and step-up transformer are used to generate high voltages for the CRT. Both positive (5 kv) and negative (2.5 kv) supplies are used, and are electronically regulated.

4-6. LOW-VOLTAGE POWER SUPPLY.

4-7. The low-voltage power supply includes an independent supply (-100 volts) and three dependent supplies (+250, +100 and -12.6 volts). The -100 volt supply is a reference for the +100 volt supply. A breakdown diode serves as the reference for the -12.6 volt supply. The +250 volt supply is obtained by stacking a 150-volt supply on top of the +100 volt supply.

4-8. Figure 4-2 is a simplified block diagram of a regulated power supply. The series regulator acts

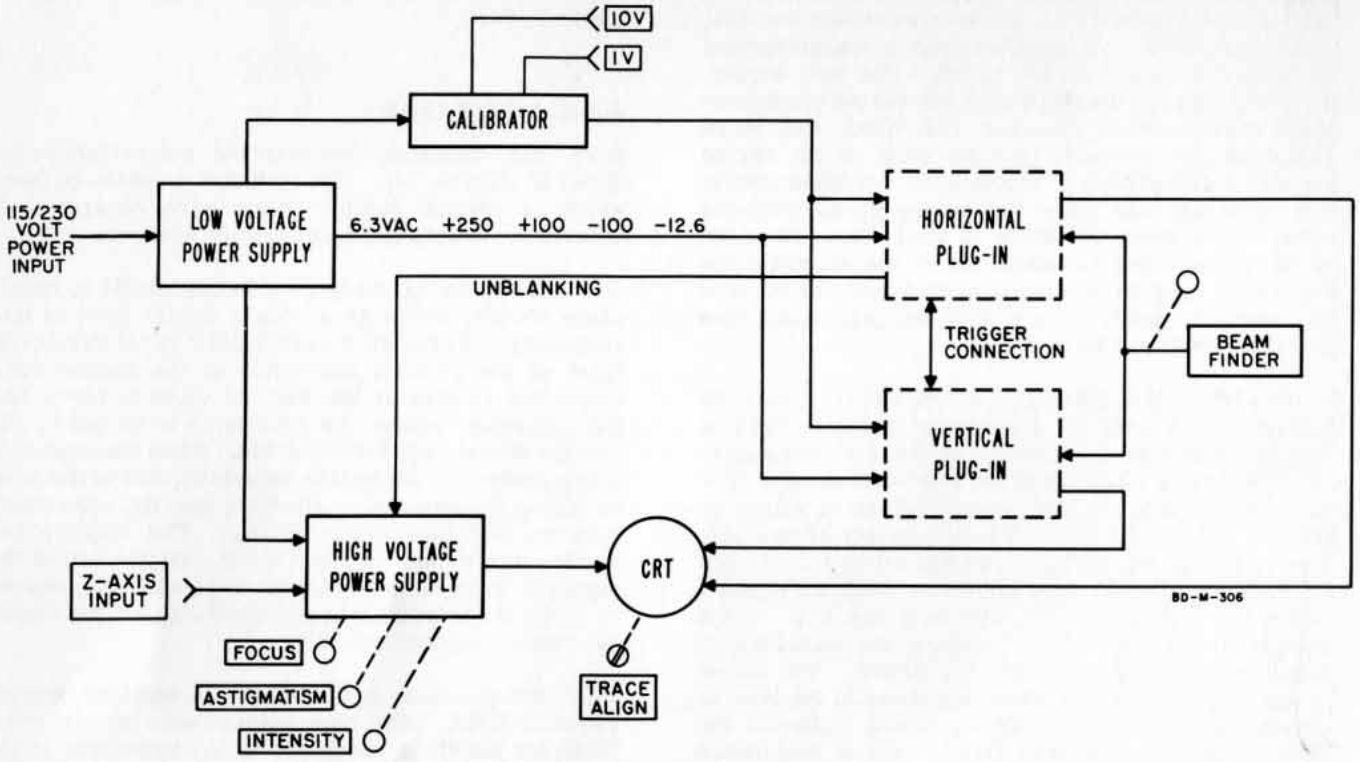


Figure 4-1. Model 140A Block Diagram

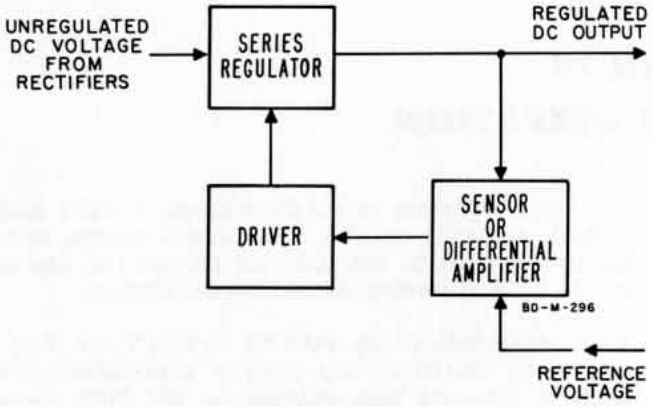


Figure 4-2. Regulated Power Supply Block Diagram

as a variable resistance in series with the supply output. A sensor or differential amplifier compares the output voltage with a reference voltage (which may be ground). The driver (either an amplifier or emitter follower) then alters the bias on the series regulator, effectively changing its series resistance. The voltage drop across the series regulator changes in such direction as to oppose any change in supply output voltage.

4-9. Figure 5-6 is a schematic diagram of the low voltage power supply in the Model 140A. The primary winding of transformer T101 is wired for quick conversion (using the 115/230 volt switch) from 115-volt to 230-volt operation. In addition to the line fuse, each of the regulated supplies is provided with over-current protection. Fuses are used for the -100, +100, and +250 volt supplies, and a transistorized protection circuit is used in the -12.6 volt supply. To reduce power dissipation in the series regulators when high-current plug-ins are used, two shunt resistors are provided across each of the series regulator transistors. Whether or not these shunts are used depends upon the wiring of the plug-ins used. Both shunt resistors in each case are of the same value. One is connected in the circuit if the horizontal plug-in is a high-current unit, the other if the vertical plug-in is a high-current unit; thus either or both may be used.

4-10. -100 VOLT REGULATED SUPPLY. The -100 volt supply is used as a reference for the +100 volt supply; therefore any change in the -100 volt supply is reflected as a change in the +100 volt supply. The AC voltage from transformer T101 is rectified by CR161-CR164, and partly filtered by capacitor C161. The resulting DC voltage is regulated by transistors Q161-Q166. Differential amplifier Q165/Q166 compares the voltage across reference tube V161 with a sample of the supply output voltage, the magnitude of which is selected by -100V Adj R200B. The output of the differential amplifier is applied to the base of emitter-follower-driver Q164, which controls the bias of series regulator Q162. Slave amplifiers Q161/Q163 reduce the power-handling requirements of Q164 by dividing the voltage drop across Q162 into three equal components. Any tendency of supply output voltage to change, either through a line surge or a change in load current, is fed back through the amplifier and driver to the series regulator, which compensates for the change by its change in series resistance. R200B adjusts the supply voltage.

4-11. +100 VOLT REGULATED SUPPLY. Sensor amplifier Q143 in the +100 volt supply senses any variation in output voltage with respect to -100 volts. The error voltage is amplified by driver Q142, which applies corrective bias to series regulator Q141. Output voltage is set by R200A, which applies approximately zero volts to the base of sensor amplifier Q143.

4-12. +250 VOLT REGULATED SUPPLY. This supply operates in the same manner as the +100 volt supply, except that +100 volts is used as the reference. Output voltage is fixed by voltage divider R136/R137.

4-13. -12.6 VOLT REGULATED SUPPLY. Sensor amplifier Q185 senses any variation of output voltage with respect to ground, and applies the error voltage to amplifier Q183. This amplifier increases signal current to the level required by emitter-follower-driver Q182 to control series regulator Q181. Output voltage is set by R200C. Transistor Q184, a protection device for the series regulator, is normally biased off. If a short occurs across the -12.6 volt output, the emitter of Q184 goes positive by the 7.5 volts across breakdown diode CR184, thus turning the transistor on. The increased positive voltage is applied through Q182 to the base of series regulator Q181, biasing this transistor off. The current which will then flow through the external short is the current available through 50-ohm resistor R183.

4-14. CALIBRATOR.

4-15. The schematic diagram of the calibrator is given in Figure 5-5. This circuit consists of three parts: a tunnel diode square wave generator, a transistor switch, and a calibration network.

4-16. 6.3 volts AC is applied through R201 to tunnel diode CR201, which generates a square wave at line frequency. Transistor switch Q201 is off during the time of the positive half-cycle of the square wave (when the voltage at the base is close to zero), and the collector voltage is thus at a level set by DC voltage divider R206-R207-R208. When the negative-going portion of the square wave is applied to the base of Q201, the transistor conducts heavily, effectively shorting the collector to ground. The output of the calibrator is thus at zero volts. At the end of the negative input half-cycle, the base of Q201 returns to zero, the transistor is switched off, and the output returns to its previous value.

4-17. Tunnel-diode bias current is supplied through resistor R202. The bias current sets an operating level for the diode which affects the symmetry of the square wave output. Cal Adj R205 is used to set the DC voltage at the collector of Q201 to -10 volts when

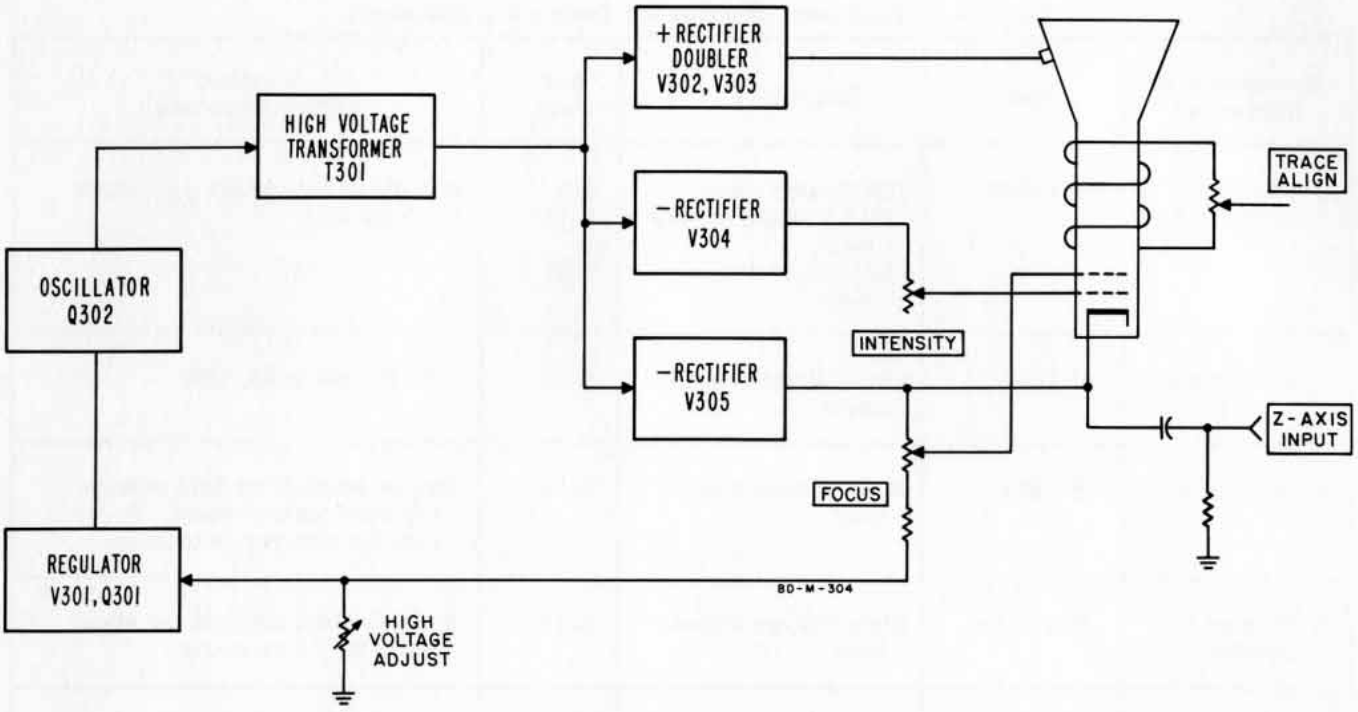


Figure 4-3. High-Voltage Power Supply Block Diagram

the transistor is off. Breakdown diode CR202 reduces the output impedance, and provides temperature compensation for the circuit. Voltage divider R207/R208 reduces the 10-volt output to 1 volt. Both 10-volt and 1-volt outputs are available on the front panel of the Model 140A.

4-18. HIGH-VOLTAGE POWER SUPPLY.

4-19. Figure 4-3 is a block diagram of the high voltage power supply. The output of a regulated transistor oscillator is stepped up in voltage and applied to a series of high-voltage rectifiers. The positive output of the voltage doubler is connected to the post-accelerator of the CRT. The negative output voltages are used in the gun assembly of the CRT and its associated controls. The Z-AXIS INPUT can be used to apply an intensity modulating signal to the cathode of the CRT.

4-20. Figure 5-8 is a schematic diagram of the high-voltage power supply, including the CRT. Oscillator Q302 operates at a frequency of about 32 kc. Any change in the output voltage is applied to the grid of V301, which converts the voltage change to a current change. This current change is applied by emitter follower Q301 to the base of the oscillator transistor. The amplitude of oscillations is changed in such direction as to oppose the original output voltage change. High Voltage Adjust R319 sets the amplitude of oscillation to produce the correct output voltage.

4-22. Two separate negative supplies are used, one for the control grid of the CRT, and one to provide CRT cathode and focusing voltages. Both supplies use half-wave rectifiers (V304 and V305). The unblanking gate from the horizontal plug-ins (via pin 1, J2) is applied to the return side of the grid supply, and changes the negative grid voltage by about +50 volts to unblank the trace. A positive pulse of about 20 volts will blank the trace when applied to Z-AXIS INPUT. When Z-AXIS INPUT is not used, S301 is set to INT to receive chopped blanking from a dual-trace plug-in.

4-22. The voltage doubler circuit (V302/V303) provides the 5-kc post-accelerating voltage required by the CRT.

4-23. The ASTIGMATISM adjustment (R341) affects the roundness of the spot, and the Geometry adjustment (R343) is used to optimize pattern shape.

4-24. TRACE ALIGN.

4-25. Trace-aligning coil L302 is located around the CRT near its screen. Adjustment of Trace Align R350A/B varies the magnitude and direction of current through the coil, which has the effect of rotating the trace. In this way the trace is brought into alignment with the CRT graticule.

Table 5-1. Equipment Required for Tests and Adjustments

Recommended Instrument	Model	Required For	Ref Para	Required Characteristics
1. Voltmeter Calibrator	℗ 738AR	Calibrator check; High Voltage Adjustment; Calibrator Adjustment	5-5 5-13 5-17	Outputs of 1v and 10v p-p; -300v DC; ±0.2%
2. DC Voltmeter	℗ 412A	Low-Voltage Adjustments	5-11	-100 to +100 volts, ±1%
3. DC VTVM	℗ 410B	High-Voltage Adjustment	5-13	May be adapted for high voltage (-2.5 kv) measurement. Provision for altering calibration.
4. Voltage Divider	℗ 11044A	High-Voltage Adjustment	5-13	Provide 100:1 division for vtvm (item 3); 2.5 kv rating.
5. Audio Oscillator	℗ 200CD	Geometry Adjustment	5-16	400 kc output.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section covers maintenance, trouble-shooting, and adjustment of the Model 140A Oscilloscope. A performance check is included which may be used at incoming inspection or after adjustments have been made to verify that the instrument meets its specifications.

5-3. PERFORMANCE CHECK.

5-4. CRT CONTROLS.

a. Install a single large plug-in or two small plug-in units in the Model 140A (vertical plug-in in the lower compartment, horizontal in the upper compartment).

b. Set: POWER . . . . . ON
AMPLIFIER coupling (if present) . AC
POSITION controls . . . . . Centered

c. If a time base plug-in is being used,

set: SWEEP TIME . . . . . 1 MSEC/CM
TRIGGER SOURCE . . . . . +INT
LEVEL . . . . . FREE RUN
NORMAL/SINGLE . . . . . NORMAL

d. A trace should be on screen. If necessary, turn INTENSITY control clockwise.

e. Remove trace from screen with POSITION controls. Depress BEAM FINDER. The trace should appear on screen.

f. The INTENSITY control should vary the intensity of the display from extinguished to brighter than normal intensity.

g. The FOCUS and ASTIGMATISM controls should defocus the display at the extreme of each control, and focus the display at approximately midrange. Adjust FOCUS and ASTIGMATISM for sharpest overall display.

h. Adjust TRACE ALIGN to set the trace parallel to the horizontal graticule lines. If the horizontal plug-in is not a time base, connect the calibrator signal to the horizontal amplifier input to produce a straight-line trace.

5-5. CALIBRATOR.

a. Set: Vertical SENSITIVITY . . . . 0.05 V/CM
INPUT coupling . . . . . DC

b. Connect 1 VOLT PTP from the Voltmeter Calibrator to vertical INPUT.

c. Adjust vertical VERNIER for exactly 10 cm deflection.

d. Disconnect the Voltmeter Calibrator and connect the 1V CALIBRATOR output to the vertical INPUT.

e. Deflection should be 10 cm ±0.1 cm.

f. Repeat steps a through e, using 0.5 V/CM vertical SENSITIVITY and 10 volts from the Voltmeter Calibrator.

5-6. ADJUSTMENTS.

5-7. The following paragraphs (5-11 through 5-17) give a complete adjustment procedure for the Model 140A Oscilloscope. A condensed procedure is given in Table 5-3. If difficulty is encountered in making any adjustment, refer to Paragraph 5-18 for trouble-shooting procedures.

5-8. EQUIPMENT NEEDED FOR ADJUSTMENTS. Test equipment recommended for the adjustment procedure is listed in Table 5-1. Similar instruments having the listed characteristics may be substituted.

5-9. LOCATION OF ADJUSTMENTS. Figure 5-2 shows the location of all internal adjustments in the Model 140A.

5-10. PRELIMINARY PROCEDURE. Plug-ins must be installed in both compartments whenever power supply voltage measurements are made; proper regulation may not occur if insufficient loading is provided. Set line voltage to 115 volts (230 volts if the 115/230 volt switch is in the 230-volt position).

5-11. ADJUSTMENT OF LOW-VOLTAGE POWER SUPPLIES.

5-12. Measure the output of each low-voltage supply, and adjust it to the value shown in Table 5-2. Measurement may be made on any wire bearing the indicated color code.

Table 5-2. Low-Voltage Adjustments

Supply (Volts)	Wire Color Code	Adjustment
-100	Violet	-100V Adj. R200B
-12.6	White/Violet	-12.6V Adj. R200C
+100	White/Red	+100V Adj. R200A

5-13. ADJUSTMENT OF HIGH-VOLTAGE SUPPLY.

a. Connect a Model 11044A 100:1 Voltage Divider to the DC probe of a Model 410B Voltmeter.

b. Set Voltmeter to 3-volt -DC range.

c. Set the Voltmeter Calibrator for -300 volts DC output, and connect divider tip to the output.

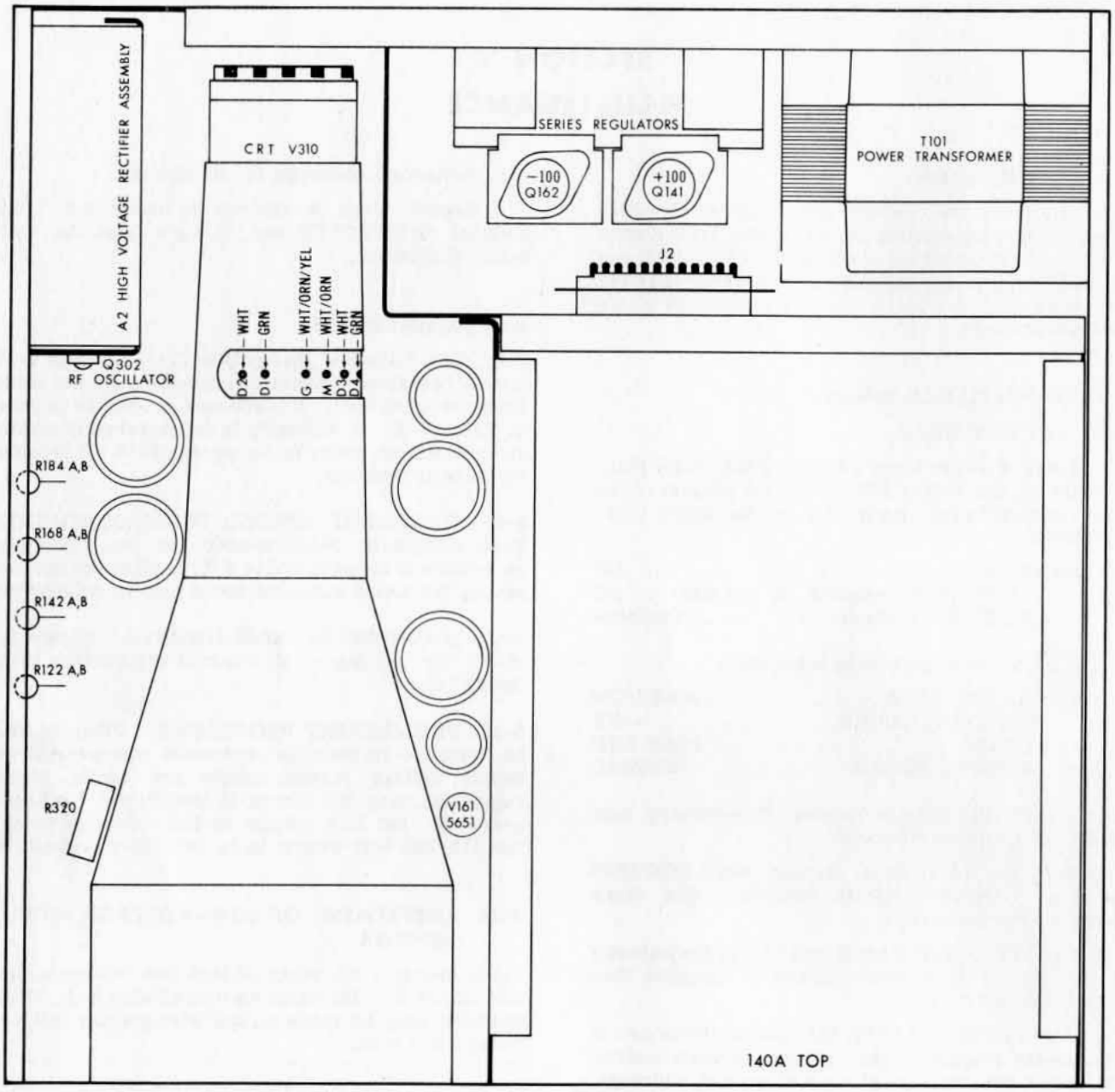


Figure 5-1. Component Locations, Top View

d. Set the gain adjustment of the Model 410B (located at the rear of the instrument) for a reading of exactly 3 volts.

e. Set the Voltmeter to the 30-volt range, and measure the high voltage supply. This may be done at the junction of R351 and R352.

f. Set High Voltage Adjust R319 for -2350 volts.

g. Recalibrate the Model 410B.

5-14. INTENSITY LIMIT ADJUSTMENT.

a. Center a defocused spot on the CRT.

b. Set INTENSITY to 10 o'clock.

c. Adjust Intensity Limit R312 until spot is just extinguished.

5-15. ASTIGMATISM ADJUSTMENT.

a. Center a low-intensity spot on the CRT.

b. Adjust FOCUS and ASTIGMATISM for a small, round, sharply-focused spot.

5-16. GEOMETRY ADJUSTMENT.

a. Set: TRIGGER LEVEL . . . . . AUTO
SWEEP TIME . . . . . 0.2 MSEC/CM

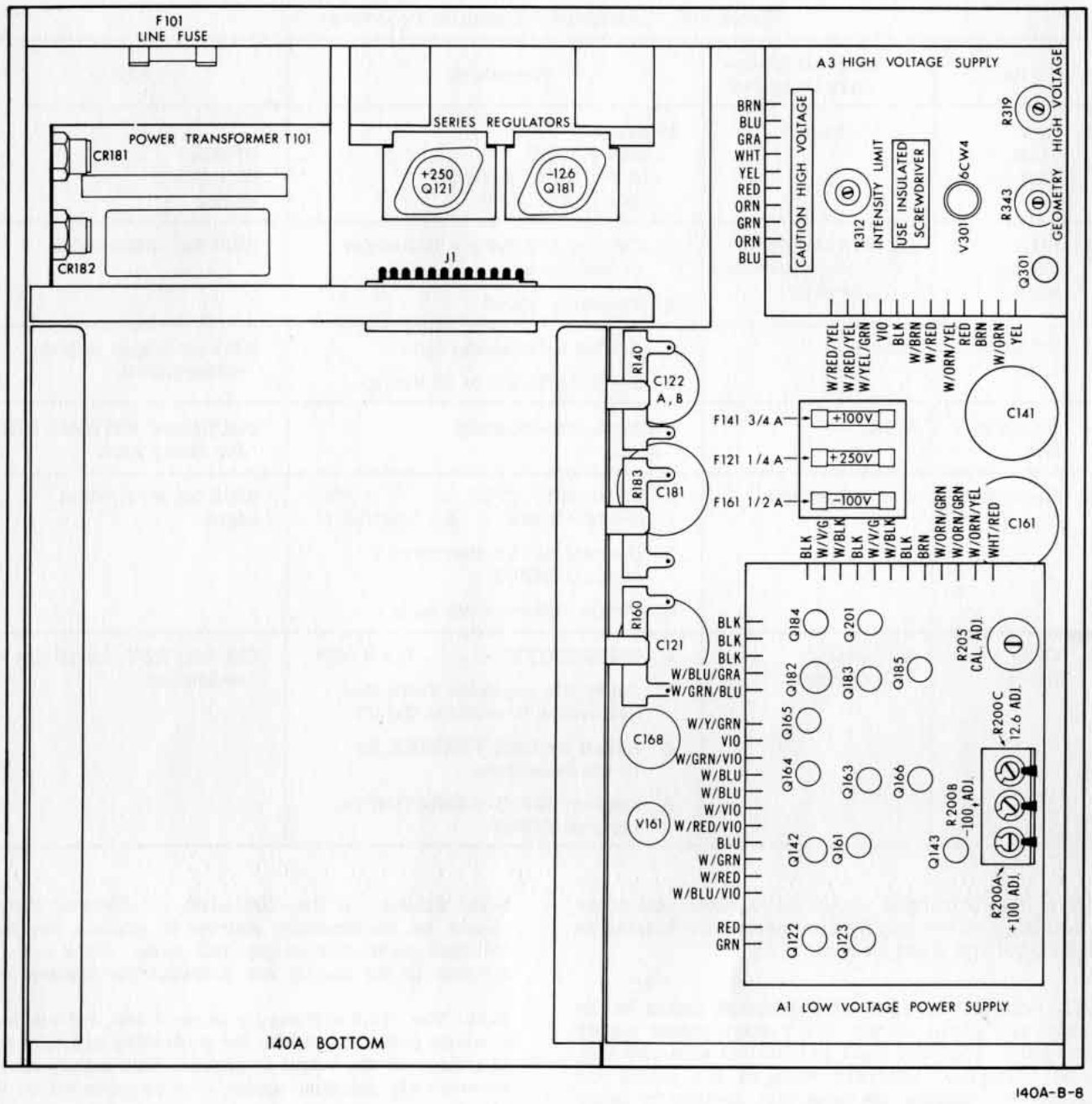


Figure 5-2. Adjustment and Component Locations, Bottom View

b. Connect a 400-kc signal from the Audio Oscillator to the vertical INPUT of the amplifier plug-in.

c. Adjust vertical and horizontal controls to obtain a pattern 8 cm high.

d. Adjust Geometry R343 to obtain the straightest possible edges on the rectangular pattern.

5-17. CALIBRATOR ADJUSTMENT.

a. Connect a 10-VOLT PTP signal from the Voltmeter Calibrator to the vertical amplifier INPUT.

b. Set amplifier SENSITIVITY to 0.5 V/CM, INPUT coupling to DC.

c. Adjust vertical VERNIER for exactly 10 cm deflection.

d. Disconnect the Voltmeter Calibrator, and connect the 10V CALIBRATOR output to the amplifier INPUT.

e. Set Cal Adj R205 for exactly 10 cm deflection.

5-18. TROUBLESHOOTING.

5-19. LOW-VOLTAGE POWER SUPPLIES.

5-20. TRANSISTORS. The series regulator transistors are located on the fan assembly. Each is easily replaced by removing the two screws and

Table 5-3. Condensed Adjustment Procedure

Test	External Equipment Required	Procedure	Adjust
1. Low Voltage Supplies	DC Voltmeter	Measure: -100v (Violet) -12.6v (White/Violet) +100v (White/Red)	 R200B R200C R200A
2. High Voltage Supply	DC VTVM; 100:1 Divider; Voltmeter Calibrator	a. Calibrate Divider - Voltmeter combination. b. Measure -2350v	R319 for -2350 volts
3. Intensity Limit	None	a. Center a defocused spot. b. Set INTENSITY to 10 o'clock.	R312 until spot is just extinguished.
4. Astigmatism	None	Center a low-intensity spot.	FOCUS and ASTIGMATISM for sharp spot.
5. Geometry	Audio Oscillator	a. TRIGGER LEVEL: . . . . AUTO SWEEP TIME: . . 0.2 MSEC/CM b. Connect 400 kc sine wave to vertical INPUT. c. Obtain pattern 8 cm high.	R343 for straightest edges.
6. Calibrator	Voltmeter Calibrator	a. SENSITIVITY: . . . . 0.5 V/CM b. Apply 10v p-p from Voltmeter Calibrator to vertical INPUT. c. Adjust vertical VERNIER for 10 cm deflection. d. Connect 10V CALIBRATOR to vertical INPUT.	Cal Adj. R205 for 10 cm deflection.

pulling the transistor from its socket. All other low voltage power supply transistors are located on the low-voltage circuit board.

5-21. Nominal voltages at significant points in the supply are given in the low-voltage power supply schematic. Plug-ins must be installed when checking these voltages. Correct voltages for points not marked for voltage are generally obvious by being connected (directly or indirectly) to a supply output. Transistor base voltage in most cases should not measurably differ from emitter voltages when measured with respect to ground. Voltage drops across breakdown diodes are indicated on the schematic.

5-22. EXCESSIVE RIPPLE. The cause of excessive 120-cycle ripple on any of the supplies can be isolated to input filter or regulator circuits by comparing ripple voltages at the rectifier outputs with the values given on the schematic. If ripple at these points is excessive, check capacitors C121, C122, C141, C161, or C181. If ripple is high and is 60 cps, one of the rectifiers is probably open. If normal, the cause is most likely low gain in the amplifier transistors. In the -100 volt supply, slave amplifiers Q161 and/or Q163 could be open, and the only indication might be poor regulation and ripple at low line voltage.

5-23. FUSES. If the -100, +100, or +250 volt supply should be accidentally shorted to ground, the fuse for that particular supply will blow. This cuts off current in the supply and protects the transistors.

5-24. The -12.6 volt supply is not fused, but employs a surge protector, Q184, for protection against brief shortings of the output to ground. The supply should immediately function normally upon removal of the short.

5-25. LOSS OF REGULATION. If loss of regulation occurs in a supply, refer to Table 5-4. The procedure outlined in this table may not always pin down the exact trouble, especially if a component other than a transistor or breakdown diode has failed, but it will usually indicate the general location of the failure. In using the procedure, follow the steps listed under a particular symptom in the given order. In some cases, more than one fault may exist.

5-26. HIGH-VOLTAGE SUPPLY.

5-27. If one high-voltage supply output is zero but other outputs are normal, look for the unlit filament of a bad rectifier (V302 thru V305). Normal DC voltages are given on the high voltage schematic.

Table 5-4. Troubleshooting the Low Voltage Supply

Supply	Symptom	Procedure	Indication	Conclusion
-100V	High Output Voltage	1. Measure voltage across CR165	Approximately 6.5 volts or less	CR165 OK
			More than approx 6.5v	CR165 open
		2. Disconnect the WHT-GRN-V10 wire from the edge of the circuit board.	Output drops	Q162 OK
			Output remains high	Q162 shorted
		3. Reconnect the WHT-GRN-V10 lead. Short emitter of Q164 to base	Output drops	Q164 OK
			Output remains high	Q164 shorted, and also possibly Q163 and Q161 (check emitter-collector resistance with ohmmeter.)
		4. Measure voltage across R173	Same as output	Q165 shorted
			Less than measured high output	Q166 open
	Low Output Voltage	1. Measure voltage across CR165	0 volts	CR165 shorted
			Approx 6 volts	CR165 OK
		2. Short WHT-GRN-VIO wire to anode end of CR165 (away from plug-in compartment).	Output remains low	Q162 open
			Output rises (more negative)	Q162 OK
		3. Short base of Q164 to the anode end of CR165 (away from plug-in compartment).	Output rises	Q164 OK
			Output remains low	Q164 or possible Q163 open
		4. Short emitter to base on Q166.	Output rises	Q165 open
			Output remains same	Q166 shorted
-12.6V	High or Low Output Voltage	1. Check the -100 volt supply	Normal	Trouble in -12.6V supply
			Abnormal	Trouble in -100V supply
	High Output Voltage	1. Remove the WHT-GRN-BLU wire from the edge of the board.	Output drops	Q181 OK
			Output remains high	Q181 shorted
		2. Replace WHT-GRN-BLU wire. Short emitter of Q182 to base.	Output drops	Q182 OK
			Output remains high	Q182 shorted
		3. Short emitter of Q185 to collector.	Output drops	Q185 open
			Output remains high	Q183 open
	Output Low	1. Lift collector of Q184 (leave disconnected for remainder of -12.6V supply tests.)	Output remains low	Q184 OK
			Output returns to normal	Q184 shorted
			Output goes higher than normal	CR184 open
		2. Short emitter of Q182 to collector	Output rises	Q181 OK
			Output remains low	Q181 open
		3. Lift collector of Q183	Output rises	Q182 OK
			Output remains low	Q182 open

Table 5-4. Troubleshotting the Low Voltage Supply (Cont'd)

Supply	Symptom	Procedure	Indication	Conclusion
-12.6V	Output Low (cont'd)	4. Replace collector of Q183 and short emitter of Q183 to base	Output rises Output remains low	Q183 OK Q183 shorted
		5. Short emitter of Q185 to base	Output remains low Output rises	Q185 shorted CR184 shorted
+100V	High or Low Output Voltage	1. Check -100V and -12.6V supplies	Normal Abnormal	Trouble in +100 volt supply Trouble in -100 or -12.6 volt supply
	High Output Voltage	1. Remove the WHT-GRN wire from the edge of the printed circuit board	Output drops Output remains high	Q141 OK Q141 shorted
		2. Replace WHT-GRN wire. Short emitter of Q142 to base.	Output drops Output remains high	Q143 shorted Q142 shorted
	Low Output Voltage	1. Short emitter of Q142 to collector	Output rises Output remains low	Q141 OK Q141 open
		2. Short emitter of Q143 to collector	Output rises Output remains low	Q143 open Q142 open
+250V	High or Low Output Voltage	1. Check -100, -12.6, and +100 supplies	Normal Abnormal	Trouble in +250 Trouble in -100, -12.6, or +100
	High Output Voltage	1. Measure voltage across CR146	Greater than approx 6.5v Approx 6.5v or less	CR146 open CR146 OK
		2. Remove green wire from edge of board	Output drops Output remains high	Q121 OK Q121 shorted
		3. Replace green wire. Short emitter of Q122 to base.	Output drops Output remains high	Q123 shorted Q122 shorted
	Low Output Voltage	1. Measure voltage across CR146	0 volts Approx 6 volts	CR142 shorted CR146 OK
		2. Short emitter of Q122 to collector	Output rises Output remains low	Q121 OK Q121 open
		3. Short emitter of Q123 to collector	Output rises Output remains low	Q123 open Q122 open

5-28. If there is no high voltage output and none of the filaments are lit, observe the waveform at the collector of Q302 (blue wire). If an approximately 30 kc 20-volt peak-to-peak sine wave appears for short intervals, the trouble is probably a defective component in the rectifier filter/divider networks. If no waveform appears, use Table 5-5.

5-29. If the high voltage output is incorrect and cannot be adjusted to the correct value, use Table 5-6.

5-30. If the -2350 volt supply seems to be operating properly, the +5 kv post-accelerator potential may be checked by removing the left side instrument cover and measuring the 5-kv voltage at the board termination of the thick red lead.

5-31. REPAIR AND REPLACEMENT.

5-32. AIR FILTER.

5-33. Inspect the air filter at the rear of the instrument and clean it before it becomes clogged enough to restrict the flow of cooling air. To clean, remove the filter from the instrument and wash it thoroughly in warm water and detergent. Dry thoroughly and coat with a filter adhesive such as Filter Coat No. 3 from Research Products Inc. This adhesive is available from heating supply stores or from your Hewlett-Packard Engineering Representative.

5-34. REMOVAL OF CATHODE-RAY TUBE.

5-35. It is recommended that a face mask or goggles and gloves be used when it is necessary to handle the CRT. To remove:

a. Disconnect post-accelerator lead. This can be done by lifting the edge of the rubber cap, and using a screwdriver to compress the spring contact until it comes free.

b. Disconnect leads at neck of CRT, taking care not to bend the pins.

c. Remove CRT bezel.

d. Loosen clamp at socket of CRT.

e. Remove socket of CRT by carefully prying loose.

f. Slide CRT forward out of instrument, keeping one hand on front face of CRT.

5-36. To install CRT, reverse the above procedure. Correct connection of leads at neck of CRT is shown on the inside of bottom cover and in Figure 5-1.

Note

If a different CRT is installed, it will be necessary to: 1) Check trace alignment with procedure given in Paragraph 3-7; 2) Reset Geometry adjustment as described in Paragraph 5-16; 3) Check plug-in calibration.

5-37. FAN MOTOR REMOVAL.

a. Disconnect the white-gray and white-green-gray wires from fan terminals at bottom of instrument.

b. Remove all four transistor heat sinks from the fan assembly, and push out of the way.

c. Remove the four nuts on rear panel which secure the fan assembly to instrument frame.

d. Lift out fan assembly.

e. Remove fan motor brackets.

5-38. To install fan, reverse the above procedure. When tightening the mounting nuts on the rear panel, use long-nose pliers or similar tool to prevent rubber shock mounts from twisting.

Table 5-5. Troubleshooting High Voltage Supply, No Voltage

1. Check Q302, L301, and the associated transformer primary for open circuits or shorts. Replace any bad components.		
Procedure	Indication	Conclusion
2. Remove the edge-on connector which goes to the emitter of Q301 (yellow wire). Connect this lead through a 2K resistor to -12.6 volts (any white-violet wire).	Rectifier (V302-V305) filaments light. Filaments don't light.	Proceed to step 3. Proceed to step 4.
3. Replace edge-on connector, and change V301.	Filaments light. Filaments don't light.	Q301 was bad. Check biasing circuitry of V301. Then check Q301 and associated circuitry.
4. Check T301 and rectifier load circuit for opens or shorts. Then lift one lead of C313, C314, C315, C316, C317, C321, and turn instrument on again.	Filaments light. Filaments don't light.	Put capacitors back one at a time until the bad one causes filaments to go out. Trouble probably with transformer T301.

Table 5-6. Troubleshooting High-Voltage Supply, Incorrect Voltage

Procedure	Effect	Conclusion
1. Remove Nuvistor V301 from its socket.	Output drops to zero. Output remains at an incorrect value.	Proceed to step 2. Q301 shorted
2. Replace V301 in its socket, and lift one end of R301.	Output drops. Output remains at an incorrect value.	Trouble probably in the resistor divider network R311, R325, R326, R327, R328, R329, R318, and R319 V301 bad.

5-39. REMOVAL OF HIGH-VOLTAGE ASSEMBLY.

a. Disconnect the six leads identified in Figure 5-3.

b. Disconnect post-accelerator lead as described in Paragraph 5-35a.

c. Remove the four screws identified in Figure 5-3.

d. Tip assembly away from left side of instrument and lift out from top.

5-40. To install high-voltage assembly, reverse the above procedure.

5-41. SERVICING ETCHED CIRCUIT BOARDS.

5-42. Etched circuit boards used in the Model 140A have components on one side of the board with a plated conductive layer of metal through component holes. Ⓗ Service Note M-20D also contains useful information on etched circuit repair. The important steps and considerations are:

a. Use a low heat (37 to 47.5 watts, less than 800°F idling temperature), slightly bent chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter, high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damage to the component (especially true for diodes). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

d. Large components such as potentiometers and tube sockets may be removed by rotating the soldering iron from lead to lead and apply steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor part of the etched circuit board is a metal plated surface, covered with solder, use care to avoid overheating and lifting the conductor from the board. A conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method for repair is to solder a section of good conducting wire along the damaged area.

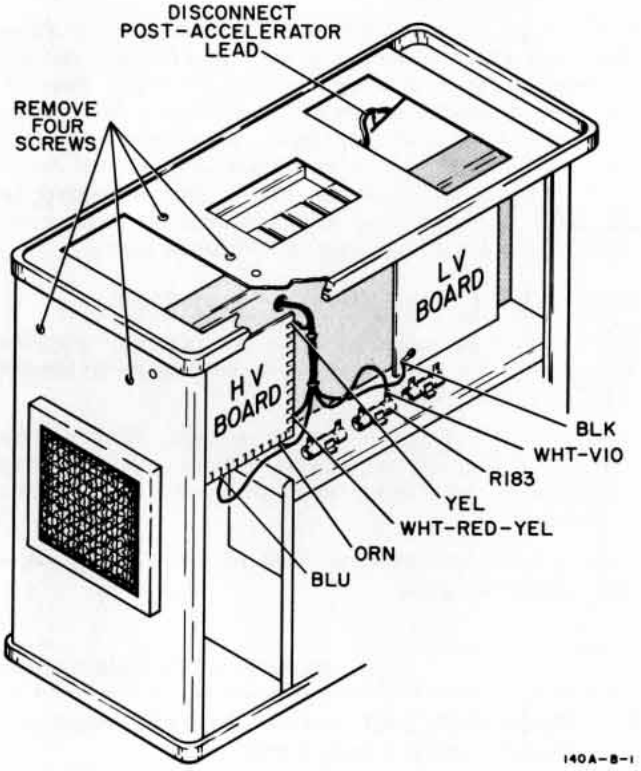


Figure 5-3. Removal of High-Deck Assembly

f. Clear the solder from the circuit board hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads in the holes and apply heat and solder, preferably on the conductor side.

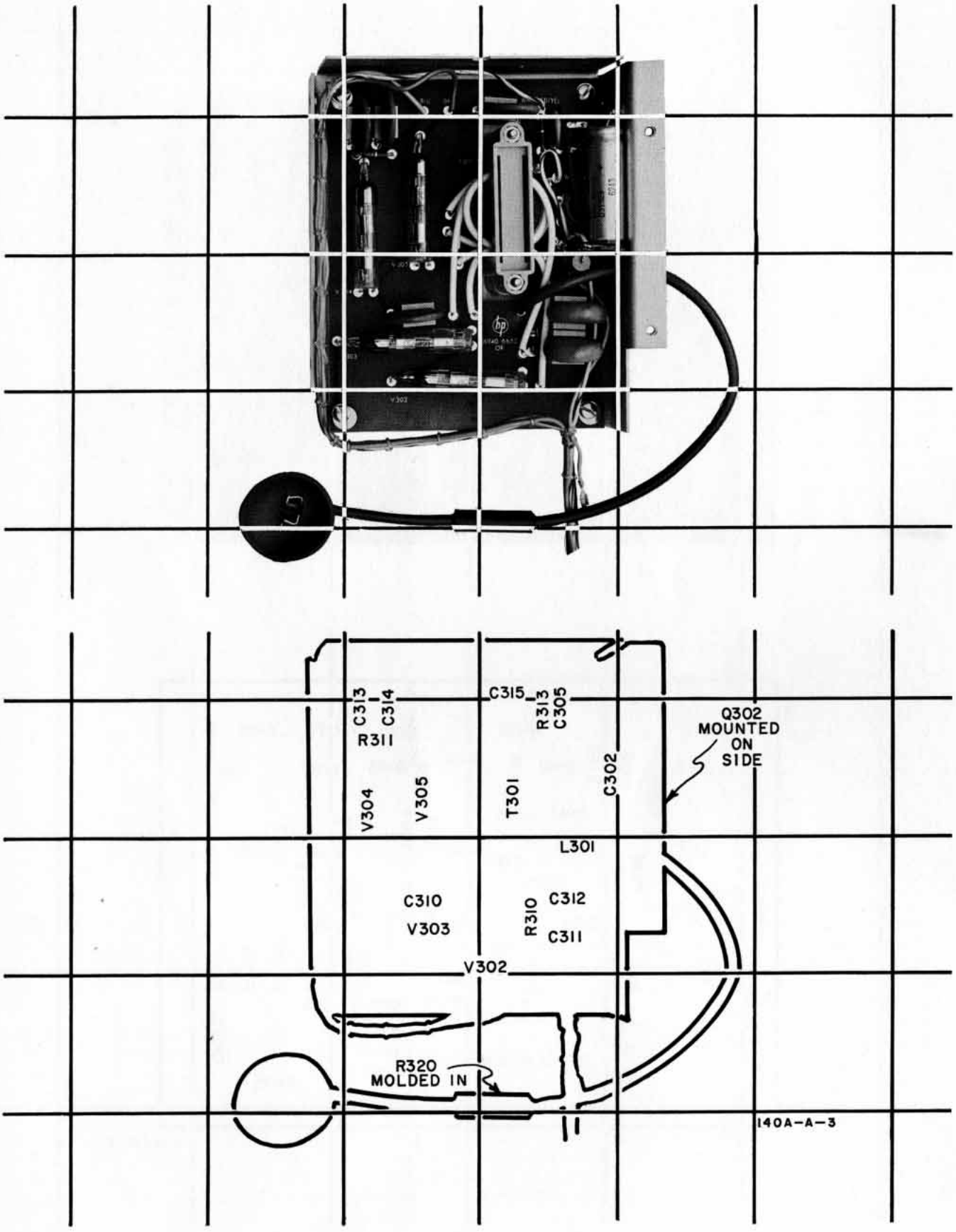


Figure 5-4. Component Locations on High Voltage Deck

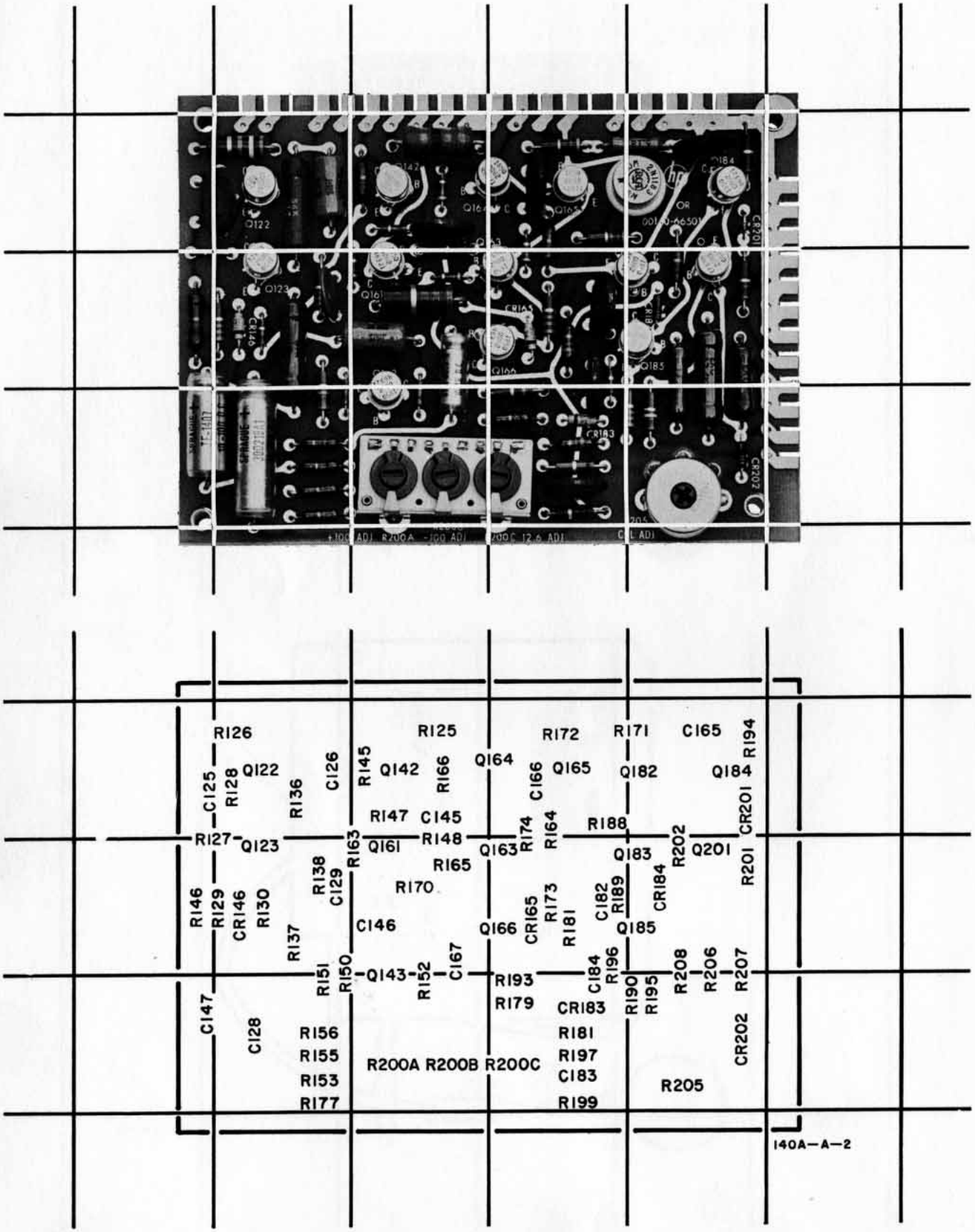


Figure 5-5. Component Location on Low-Voltage Board

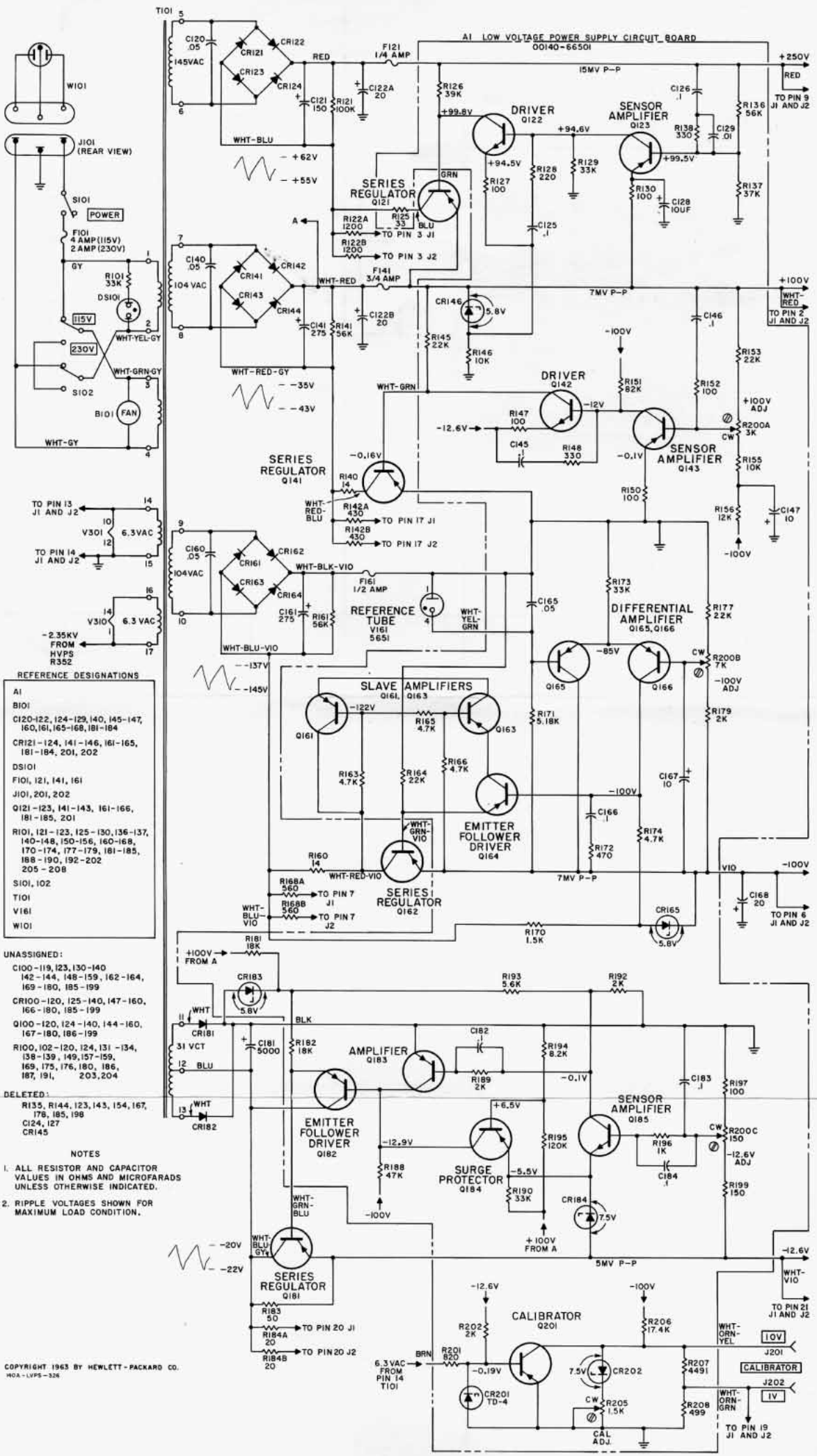


Figure 5-6. Low Voltage Power Supply

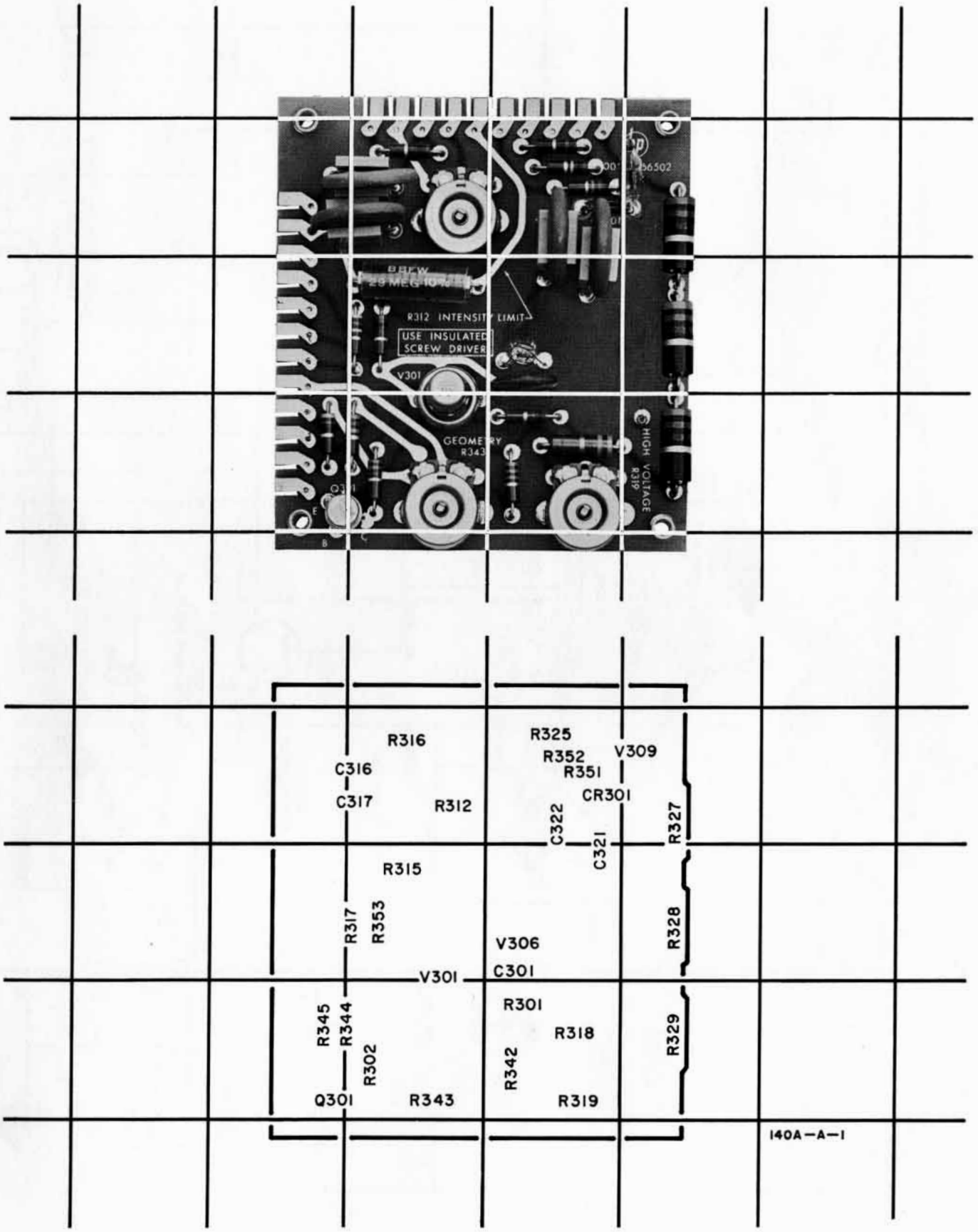
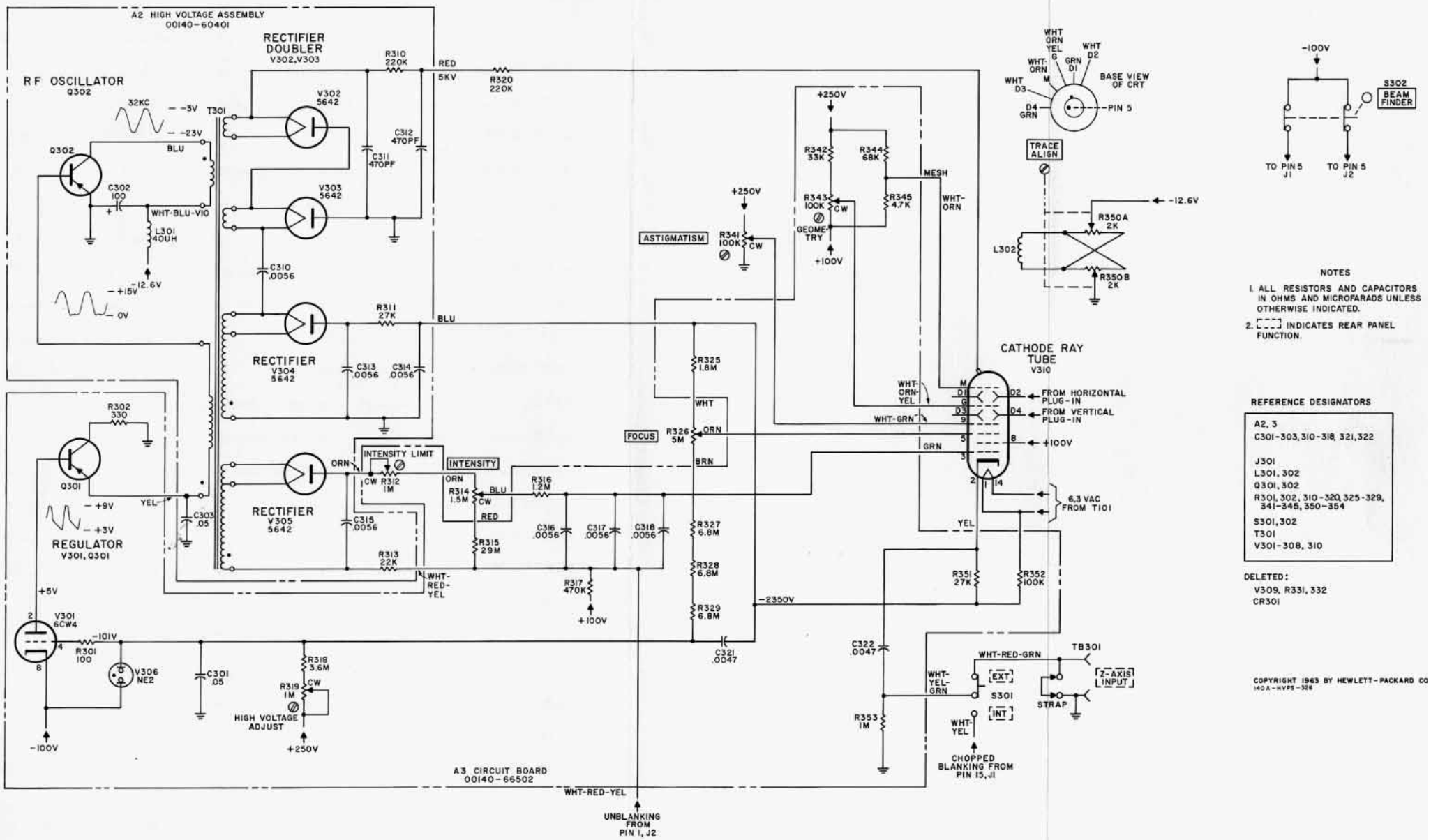


Figure 5-7. Component Locations on High-Voltage Board



NOTES

1. ALL RESISTORS AND CAPACITORS IN OHMS AND MICROFARADS UNLESS OTHERWISE INDICATED.
2. [ ] INDICATES REAR PANEL FUNCTION.

REFERENCE DESIGNATORS

A2, 3
C301-303, 310-318, 321, 322
J301
L301, 302
Q301, 302
R301, 302, 310-320, 325-329, 341-345, 350-354
S301, 302
T301
V301-308, 310

DELETED:
V309, R331, 332
CR301

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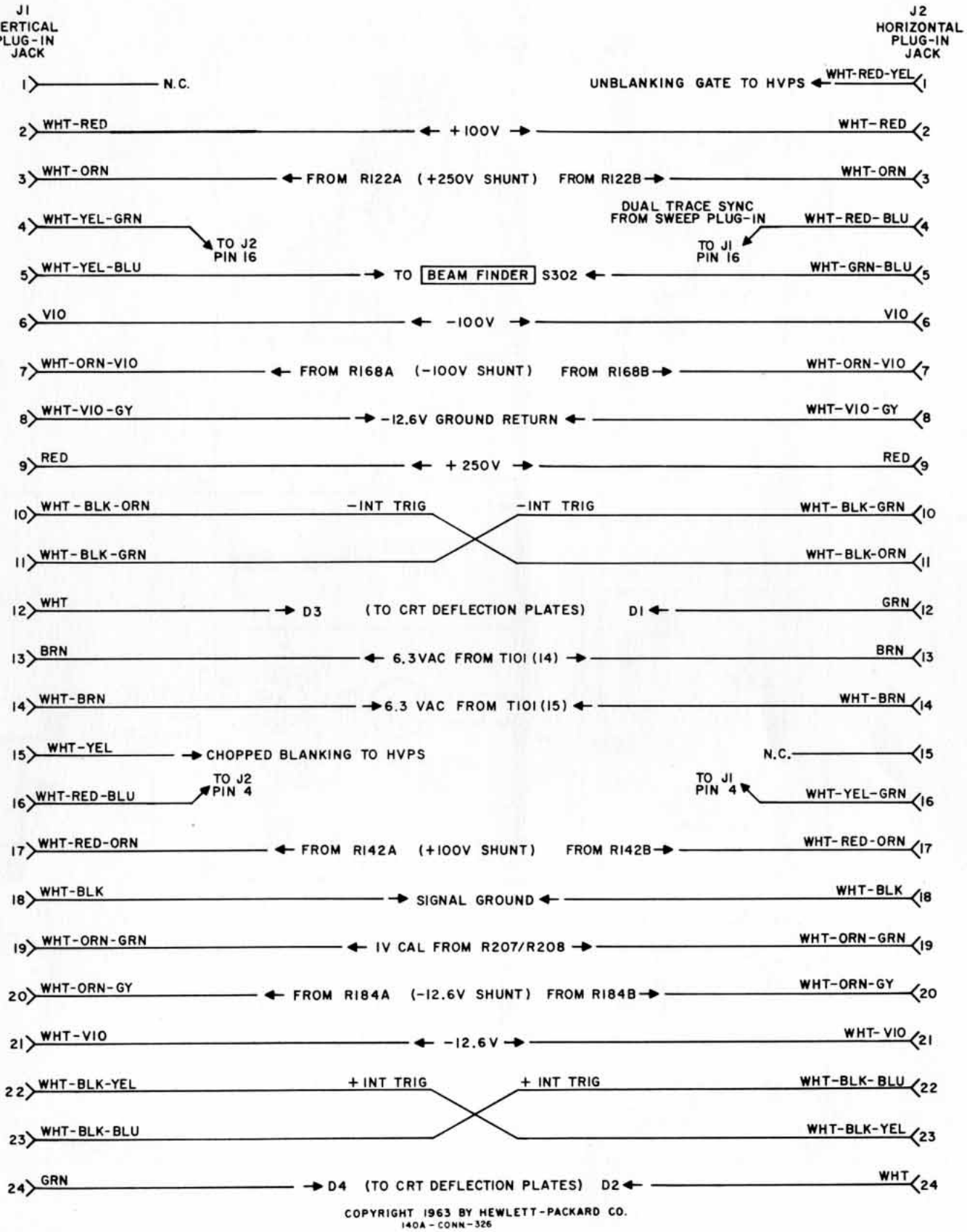
140A-HVPS-328

Figure 5-8. High Voltage Power Supply


J1 VERTICAL PLUG-IN JACK
J2 HORIZONTAL PLUG-IN JACK
1 N.C.
UNBLANKING GATE TO HVPS WHT-RED-YEL 1
2 WHT-RED + 100V WHT-RED 2
3 WHT-ORN FROM R122A (+250V SHUNT) FROM R122B WHT-ORN 3
4 WHT-YEL-GRN TO J2 PIN 16
DUAL TRACE SYNC FROM SWEEP PLUG-IN
WHT-RED-BLU 4
TO J1 PIN 16
5 WHT-YEL-BLU TO BEAM FINDER S302 WHT-GRN-BLU 5
6 VIO -100V VIO 6
7 WHT-ORN-VIO FROM R168A (-100V SHUNT) FROM R168B WHT-ORN-VIO 7
8 WHT-VIO-GY -12.6V GROUND RETURN WHT-VIO-GY 8
9 RED + 250V RED 9
10 WHT-BLK-ORN -INT TRIG -INT TRIG WHT-BLK-GRN 10
11 WHT-BLK-GRN WHT-BLK-ORN 11
12 WHT D3 (TO CRT DEFLECTION PLATES) D1 GRN 12
13 BRN 6.3VAC FROM T101 (14) BRN 13
14 WHT-BRN 6.3 VAC FROM T101 (15) WHT-BRN 14
15 WHT-YEL CHOPPED BLANKING TO HVPS N.C. 15
16 WHT-RED-BLU TO J2 PIN 4
TO J1 PIN 4
WHT-YEL-GRN 16
17 WHT-RED-ORN FROM R142A (+100V SHUNT) FROM R142B WHT-RED-ORN 17
18 WHT-BLK SIGNAL GROUND WHT-BLK 18
19 WHT-ORN-GRN IV CAL FROM R207/R208 WHT-ORN-GRN 19
20 WHT-ORN-GY FROM R184A (-12.6V SHUNT) FROM R184B WHT-ORN-GY 20
21 WHT-VIO -12.6V WHT-VIO 21
22 WHT-BLK-YEL +INT TRIG +INT TRIG WHT-BLK-BLU 22
23 WHT-BLK-BLU WHT-BLK-YEL 23
24 GRN D4 (TO CRT DEFLECTION PLATES) D2 WHT 24
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140A-CONN-326

Figure 5-9. Plug-In Connectors

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and hp stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their hp stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in Table 6-1 are listed at the end of Table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry either to your nearest Hewlett-Packard field office or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S.A.
54-54bis Route des Acacias
Geneva, Switzerland

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in Tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A = assembly	F = fuse	P = plug	V = vacuum tube, neon bulb, photocell, etc.
B = motor	FL = filter	Q = transistor	W = cable
C = capacitor	J = jack	R = resistor	X = socket
CR = diode	K = relay	RT = thermistor	Y = crystal
DL = delay line	L = inductor	S = switch	Z = network
DS = device signaling (lamp)	M = meter	T = transformer	
E = misc electronic part	MP = mechanical part		

ABBREVIATIONS

A = amperes	F = farads	NC = normally closed	S-B = slow-blow
BP = bandpass	FXD = fixed	NE = neon	SE = selenium
BWO = backward wave oscillator	GE = germanium	NO = normally open	SECT = section(s)
	GL = glass	NPO = negative positive zero (zero temperature coefficient)	SI = silicon
CER = ceramic	GRD = ground(ed)		SIL = silver
CMO = cabinet mount only	H = henries	NSR = not separately replaceable	SL = slide
COEF = coefficient	HG = mercury		SPL = special
COM = common	HR = hour(s)	OBD = order by description	TA = tantalum
COMP = composition	IMPG = impregnated	OX = oxide	TD = time delay
CONN = connection	INCD = incandescent		TI = titanium dioxide
CRT = cathode-ray tube	INS = insulation(ed)	P = peak	TOG = toggle
DEPC = deposited carbon	K = kilo = 1000	PC = printed circuit board	TOL = tolerance
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by hp stock numbers.	LIN = linear taper	PF = picofarads = 10^{-12} farads	TRIM = trimmer
	LOG = logarithmic taper	PP = peak-to-peak	TWT = traveling wave tube
	MEG = meg $=10^{6}$	PIV = peak inverse voltage	U = micro $=10^{-6}$
	M = milli $=10^{-3}$	POR = porcelain	VAC = vacuum
	MINAT = miniature	POS = position(s)	VAR = variable
	METFLM = metal film	POLY = polystyrene	W/ = with
	MFR = manufacturer	POT = potentiometer	W = watts
	MOM = momentary	RECT = rectifier	WW = wirewound
	MTG = mounting	ROT = rotary	W/O = without
	MY = mylar	RMS = root-mean-square	* = optimum value selected at factory, average value shown (part may be omitted)
ELECT = electrolytic		RMO = rack mount only	
ENCAP = encapsulated			

01194-7

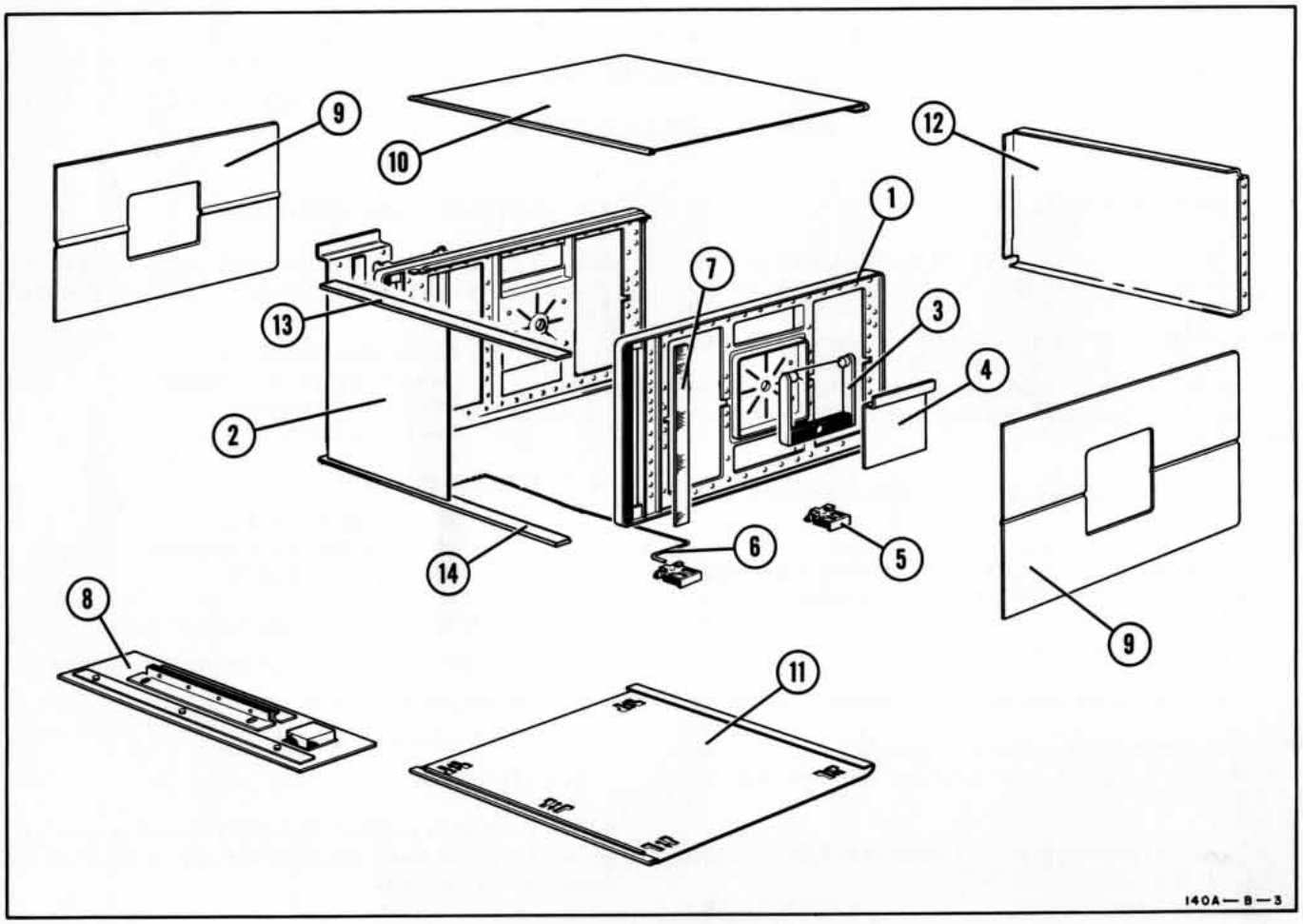

Figure 6-1. Cabinet Parts, Exploded View

	Part	Stock Number	Quantity
1.	Frame Assembly	5060-0736	2
2.	Front Panel	00140-00201	1
3.	Side Handle Assembly	5060-0763	2
4.	Handle Retainer	5060-0765	2
5.	Foot Assembly	5060-0767	5
6.	Tilt Stand	1490-0030	1
7.	Plastic Trim	6980-0004	2
8.	Rack Mount Kit	5060-0777	1
9.	Side Cover	5000-0747	2
10.	Top Cover Assembly	5060-0740	1
11.	Bottom Cover Assembly	00140-04401	1
12.	Rear Panel	00140-00202	1
13.	Top Panel Support	00140-24701	1
14.	Bottom Panel Support	00140-24702	1

Table 6-1. Reference Designation Index

Reference Designation	Stock No.	Description #	Note
A1	00140-66501	LV SUPPLY ASSEMBLY	
A2	00140-60401	HV DECK ASSEMBLY	
A3	00140-66502	HV SUPPLY ASSEMBLY	
A4		NOT ASSIGNED	
A5	00140-61606	CABLE CRT POST ACCELERATOR	
B101	3160-0026	FAN:MUFFIN 105 120 V, 50-60 CPS	
C120	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C121	0180-0147	C:FXD ELECT 150UF -10+50% 250VDCW	
C122	0180-0012	C:FXD ELECT 2X20 UF 450VDCW	
C123 THRU C124		NOT ASSIGNED	
C125	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C126	0160-0168	C:FXD MYLAR 0.1UF 10%	
C127		NOT ASSIGNED	
C128	0180-0089	C:FXD ELECT 10UF-10%+100% 150VDCW	
C129	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C130 THRU C139		NOT ASSIGNED	
C140	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C141	0180-0212	C:FXD ELECT 250UF 12VDCW	
C142 THRU C144		NOT ASSIGNED	
C145	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C146	0160-0168	C:FXD MYLAR 0.1UF 10%	
C147	0180-0091	C:FXD ELECT 10UF 100VDCW	
C148 THRU C159		NOT ASSIGNED	
C160	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C161	0180-0212	C:FXD ELECT 250UF 12VDCW	
C162 THRU C164		NOT ASSIGNED	
C165	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C166	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C167	0180-0059	C:FXD 10 UF -10%+100% 25VDCW	
C168	0180-0093	C:FXD ELECT 20UF 150VDCW	
C169 THRU C180		NOT ASSIGNED	
C181	0180-0213	C:FXD ELECT 5000UF 25VDCW	
C182	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C183	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C184	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C185 THRU C300		NOT ASSIGNED	
C301	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C302	0180-0138	C:FXD ELECT 100UF -10+100% 40VDCW	
C303	0150-0096	C:FXD CER 0.05UF 100VDCW	
C304 THRU C309		NOT ASSIGNED	
C310	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C311	0150-0036	C:FXD CER 470 PF 20% 6KV	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
C312	0150-0036	C:FXD CER 470 PF 20% 6KV	
C313	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C314	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C315	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C316	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C317	0160-0384	C:FXD 5600PF +80-20% 3KVDCW	
C318 THRU C320		NOT ASSIGNED	
C321	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C322	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
CR121	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR122 THRU CR123		NOT ASSIGNED	
CR124	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR125 THRU CR140		NOT ASSIGNED	
CR141	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR142 THRU CR143		NOT ASSIGNED	
CR144	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR145		NOT ASSIGNED	
CR146	1902-0034	SEMICON DEVICE :DIODE	
CR147 THRU CR160		NOT ASSIGNED	
CR161	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR162 THRU CR163		NOT ASSIGNED	
CR164	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR165	1902-0034	SEMICON DEVICE:DIODE	
CR166 THRU CR180		NOT ASSIGNED	
CR181	1901-0032	SEMICON DEVICE: DIODE 1N3209JUNCTION	
CR182	1901-0032	SEMICON DEVICE: DIODE 1N3209JUNCTION	
CR183	1902-0034	SEMICON DEVICE: DIODE	
CR184	1902-0009	SEMICON DEVICE: DIODE 1N755 250MW	
CR185 THRU CR200		NOT ASSIGNED	
CR201	1912-0006	SEMICON DEVICE: DIODE GER TUNNEL	
CR202	1902-0009	SEMICON DEVICE: DIODE 1N755 250MW	
DS101	1450-0048	LAMP:PILOT NE2H	
F101	2110-0014	FUSE:CARTRIDGE 4 AMP 125V SLOW BLOW	
F102 THRU F120		NOT ASSIGNED	
F121	2110-0004	FUSE:CARTRIDGE 1/4 AMP 250V	
F122 THRU F140		NOT ASSIGNED	
F141	2110-0033	FUSE: 0.75AMP 250V	
F142 THRU F160		NOT ASSIGNED	
F161	2110-0012	FUSE:CARTRIDGE 1/2AMP 250V	
J1	1251-0054	CONNECTOR:FEMALE 24-CONTACT	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
J2	1251-0054	CONNECTOR:FEMALE 24-CONTACT	
J3 THRU			
J100		NOT ASSIGNED	
J101	1251-0148	CONNECTOR:POWER	
J102 THRU			
J200		NOT ASSIGNED	
J201	1251-0202	CONNECTOR:BANANA JACK	
J202	1251-0202	CONNECTOR:BANANA JACK	
L301	9140-0171	COIL-FXD 40UH 10% 1 AMP	
L302	5060-0408	COIL-ALIGNMENT	
Q121	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q122	1851-0017	TRANSISTOR:2N1304	
Q123	1850-0062	TRANSISTOR:GERMANIUM	
Q124 THRU			
Q140		NOT ASSIGNED	
Q141	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q142	1851-0017	TRANSISTOR:2N1304	
Q143	1850-0062	TRANSISTOR:GERMANIUM	
Q144 THRU			
Q160		NOT ASSIGNED	
Q161	1850-0062	TRANSISTOR:GERMANIUM	
Q162	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q163	1850-0062	TRANSISTOR:GERMANIUM	
Q164	1850-0062	TRANSISTOR:GERMANIUM	
Q165	1850-0062	TRANSISTOR:GERMANIUM	
Q166	1850-0062	TRANSISTOR:GERMANIUM	
Q167 THRU			
Q180		NOT ASSIGNED	
Q181	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q182	1850-0064	TRANSISTOR:GERMANIUM 2N1183 PNP	
Q183	1850-0062	TRANSISTOR:GERMANIUM	
Q184	1850-0062	TRANSISTOR:GERMANIUM	
Q185	1851-0017	TRANSISTOR:2N1304	
Q186 THRU			
Q200		NOT ASSIGNED	
Q201	1850-0062	TRANSISTOR:GERMANIUM	
Q202 THRU			
Q300		NOT ASSIGNED	
Q301	1850-0062	TRANSISTOR:GERMANIUM	
Q302	1850-0143	TRANSISTOR:PNP GERMANIUM	
R101	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R102 THRU			
R120		NOT ASSIGNED	
R121	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R122	0815-0031	R:FXD WW 2400 OHM 5%	
R123 THRU			
R124		NOT ASSIGNED	
R125	0764-0033	R:FXD MET OX 33 OHM 5% 2W	
R126	0690-3931	R:FXD COMP 39K OHMS 10% 1W	
R127	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R128	0687-2211	R:FXD 220 OHMS 10% 1/2W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R129	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R130	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R131 THRU R135		NOT ASSIGNED	
R136	0730-0053	R:FXD DEPC 56K OHMS 1% 1W	
R137	0730-0049	R:FXD DEPC 37K OHMS 1% 1W	
R138	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R139		NOT ASSIGNED	
R140	0816-0019	R:FXD WW 14 OHMS 10% 10W	
R141	0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	
R142	0815-0029	R:FXD 1780 OHM 5%	
R143 THRU R144		NOT ASSIGNED	
R145	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R146	0761-0006	R:FXD MET FLM 10K OHM 5% 1W	
R147	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R148	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R149		NOT ASSIGNED	
R150	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R151	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R152	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R153	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R154		NOT ASSIGNED	
R155	0758-0006	R:FXD MET FLM 10K OHMS 5% 0.5W	
R156	0758-0012	R:FXD MET FLM 12K OHMS 5% 1/2W	
R157 THRU R159		NOT ASSIGNED	
R160	0816-0019	R:FXD WW 14 OHMS 10% 10W	
R161	0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	
R162		NOT ASSIGNED	
R163	0684-4721	R:FXD COMP 4700 OHMS 10% 1/4W	
R164	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R165	0684-4721	R:FXD COMP 4700 OHMS 10% 1/4W	
R166	0684-4721	R:FXD COMP 4700 OHMS 10% 1/4W	
R167		NOT ASSIGNED	
R168	0815-0030	R:FXD WW 1120 OHM CT 5%	
R169		NOT ASSIGNED	
R170	0693-1521	R:FXD COMP 1500 OHMS 10% 2W	
R171	0727-0137	R:FXD DEPC 5.18K OHMS 1% 1/2W	
R172	0687-4711	R:FXD 470 OHMS 10% 1/2W	
R173	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R174	0684-4721	R:FXD COMP 4700 OHMS 10% 1/4W	
R175 THRU R176		NOT ASSIGNED	
R177	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R178		NOT ASSIGNED	
R179	0758-0033	R:FXD MET FLM 2000 OHMS 5% 1/2W	
R180		NOT ASSIGNED	
R181	0758-0019	R:FXD MET FLM 18K OHMS 5% 1/2W	
R182	0758-0019	R:FXD MET FLM 18K OHMS 5% 1/2W	
R183	0816-0015	R:FXD WW 50 OHMS 10% 10W	

 # See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Stock No.	Description #	Note
R184	0815-0028	R:FXD WW 80 OHM 5%	
R185 THRU R187		NOT ASSIGNED	
R188	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R189	0683-2025	R:FXD COMP 2000 OHMS 5% 1/4W	
R190	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R191 THRU R192		NOT ASSIGNED	
R193	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	
R194	0687-8221	R:FXD COMP 8200 OHMS 10% 1/2W	
R195	0687-1241	R:FXD COMP 120K OHMS 10% 1/2W	
R196	0684-1021	R:FXD COMP 1000 OHM 10% 1/4W	
R197	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R198		NOT ASSIGNED	
R199	0687-1511	R:FXD COMP 150 OHMS 10% 1/2W	
R200	2100-0443	R:VAR 200X3000X7000 OHMS	
R201	0687-8211	R:FXD 820 OHMS 10% 1/2W	
R202	0686-2025	R:FXD COMP 2000 OHMS 5% 1/2W	
R203 THRU R204		NOT ASSIGNED	
R205	2100-0330	R:VAR WW 1500 OHM 10% LIN	
R206	0730-0153	R:FXD DEPC 17.4K OHMS 1% 1W	
R207	0727-0393	R:FXD DEP C 4.491K OHM 1/2% 1/2W	
R208	0727-0394	R:FXD DEP C 499 OHM 1/2% 1/2W	
R209 THRU R300		NOT ASSIGNED	
R301	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R302	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R303 THRU R309		NOT ASSIGNED	
R310	0687-2241	R:FXD COMP 220K OHMS 10% 1/2W	
R311	0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R312	2100-0096	R:VAR COMP 1MEGOHM 30% LIN 1/5W	
R313	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R314	2100-0756	R:VAR COMP 1.5 MEGOHM	
R315	0836-0003	R:FXD DEPC 29M OHMS 10% 1W	
R316	0687-1251	R:FXD COMP 1.2MEGOHMS 10% 1/2W	
R317	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R318	0689-3655	R:FXD COMP 3.6MEGOHMS 5% 1W	
R319	2100-0096	R:VAR COMP 1MEGOHM 30% LIN 1/5W	
R320		NSR PART OF A5	
R321 THRU R324		NOT ASSIGNED	
R325	0687-1851	R:FXD COMP 1.8MEGOHMS 10% 1/2W	
R326	2100-0374	R:VAR COMP 5M OHM 30% LIN 0.5W	
R327	0693-6851	R:FXD COMP 6.8MEGOHMS 10% 2W	
R328	0693-6851	R:FXD COMP 6.8MEGOHMS 10% 2W	
R329	0693-6851	R:FXD COMP 6.8MEGOHMS 10% 2W	
R330 THRU R340		NOT ASSIGNED	
R341	2100-0212	R:VAR COMP 100K OHMS 10% LIN 2W	
R342	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation		Stock No.	Description #	Note
R343		2100-0095	R:VAR COMP 100K OHMS 30% LIN 1/5W	
R344		0687-6831	R:FXD 68K OHMS 10% 1/2W	
R345		0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	
R346	THRU			
R349			NOT ASSIGNED	
R350		2100-0445	R:VAR 2K OHMS 30% LIN	
R351		0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R352		0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R353		0687-1051	R:FXD COMP 1MEGOHM 10% 1/2W	
S101		3101-0030	SWITCH:TOG SPST 15 AMP 125 VAC	
S102		3101-0033	SWITCH:SLIDE DPDT	
S103	THRU			
S300			NOT ASSIGNED	
S301		3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	
S302		3101-0092	SWITCH:PUSHBUTTON DPST NC	
T101		9100-0184	TRANSFORMER:POWER	
T102	THRU			
T300			NOT ASSIGNED	
T301		00140-86001	TRANSFORMER-HV COIL	
TB301		0360-0104	STRIP:TERMINAL	
V161		1940-0001	TUBE:ELECTRON 5651	
V162	THRU			
V300			NOT ASSIGNED	
V301		1921-0013	TUBE:ELECTRON6CW4	
V302		1920-0001	ELECTRON TUBE: 5642	
V303		1920-0001	ELECTRON TUBE: 5642	
V304		1920-0001	ELECTRON TUBE: 5642	
V305		1920-0001	ELECTRON TUBE: 5642	
V306		2140-0008	LAMP:NEON NE2	
V307	THRU			
V309			NOT ASSIGNED	
V310		5083-0652	TUBE:CATHODE RAY	
W101		8120-0078	CABLE POWER SVT-18-3 7.5FT.	
XQ302		1200-0112	SOCKET:TRANSISTOR	
XV161		1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV162	THRU			
XV300			NOT ASSIGNED	
XV301		1200-0086	SOCKET:NUVISTOR 5-PIN	
			MISCELLANEOUS	
		G-83U	INSULATOR-FOT	
		G-74CA	KNOB-INTENSITY, FOCUS	
		120A-20A	BEZEL-CRT	
		00140-00201	PANEL-FRONT	
		00140-00601	SHIELD-PLUG-IN	
		00140-04401	COVER-BOTTOM	
		00140-61606	CABLE:CRT POST ACCELERATOR	
		0510-0123	FASTENER:PUSH-ON TYPE,PILOT LIGHT	
		1200-0037	SOCKET:CRT TUBE	
		00140-24701	SUPPORT:TOP PANEL	
		00140-24702	SUPPORT:BOTTOM PANEL	

 # See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
	1200-0050	PIN:CRT SOCKET	
	1251-0207	CONNECTOR:PC 20-22 AWG WIRE	
	1400-0008	HOLDER:FUSE	
	1400-0123	FUSEHOLDER 3 POLE FOR 1/4X1-1/4 FUSE	
	1450-0048	LAMP:PILOT NE2H	
	1490-0030	STAND:TILT	
	1520-0018	MOUNT-VIBRATION	
	2110-0006	FUSE:CARTRIDGE 2AMP 125V SLOW BLOW	
	5000-0747	COVER:SIDE	
	5040-0402	MOUNT:HV TRANSFORMER	
	5060-0736	FRAME:8 X 16 FM CASTING	
	5060-0740	TOP COVER ASSY. 16L FM	
	5060-0763	HANDLE ASSY-SIDE	
	5060-0765	RETAINER-HANDLE ASSY.	
	5060-0767	FOOT ASSY-FM	
	5060-0777	KIT:RACK MOUNT	
	5060-0878	FILTER:AIR	
	6960-0016	PLUGBUTTON:NYLON	
	6980-0004	TRIM:PLASTIC	
	9170-0017	CORE:FERRITE	
	9170-0060	CORE:FERRITE	

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
G-74CA	KNOB-INTENSITY, FOCUS	28480	G-74CA	2	1
G-83U	INSULATOR-POT	28480	G-83U	1	1
00140-00201	PANEL-FRONT	28480	00140-00201	1	1
00140-00601	SHIELD-PLUG-IN	28480	00140-00601	1	1
00140-04401	COVER-BOTTOM	28480	00140-04401	1	1
00140-60401	HV DECK ASSEMBLY	28480	00140-60401	1	1
00140-61606	CABLE:CRT POST ACCELERATOR	28480	00140-61606	2	1
00140-66501	LV SUPPLY ASSEMBLY	28480	00140-66501	1	1
00140-66502	HV SUPPLY ASSEMBLY	28480	00140-66502	1	1
00140-86001	TRANSFORMER-HV COIL	28480	00140-86001	1	1
120A-20A	BEZEL-CRT	28480	120A-20A	1	1
5083-0652	TUBE:CATHODE RAY	28480	5083-0652	1	1
0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	56289	H 1038	1	1
0150-0036	C:FXD CER 470 PF 20% 6KV	91418	#6KV470 20%	2	1
0150-0052	C:FXD 0.05 UF 20% 400 VDCW	05729	20X503MC4	5	1
0150-0084	C:FXD 0.1UF +80-20% 50VDCW	56289	33C41	6	2
0150-0096	C:FXD CER 0.05UF 100VDCW	91418	-TA	1	1
0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	71590	DA172-097CB	2	1
0160-0168	C:FXD MYLAR 0.1UF 10%	28480	0160 0168	2	1
0160-0384	C:FXD 5600PF +80-20% 3KVDCW	71590	DA172-098CB	6	2
0180-0012	C:FXD ELECT 2X20 UF 450VDCW	56289	D32440	1	1
0180-0059	C:FXD 10 UF -10%+100% 25VDCW	56289	30D182A1	1	1
0180-0089	C:FXD ELECT 10UF-10%+100% 150VDCW	56289	30D218A1	1	1
0180-0091	C:FXD ELECT 10UF 100VDCW	56289	30D208A1	1	1
0180-0093	C:FXD ELECT 20UF 150VDCW	56289	D32610	1	1
0180-0138	C:FXD ELECT 100UF -10+100% 40VDCW	56289	TYPE 41D	1	1
0180-0147	C:FXD ELECT 150UF -10+50% 250VDCW	00853	PLI	1	1
0180-0212	C:FXD ELECT 250UF 12VDCW	56289	TYPE 30D157A1	2	1
0180-0213	C:FXD ELECT 5000UF 25VDCW	00853	PLI	1	1
0360-0104	STRIP:TERMINAL	71785	321-11-02-036	1	1
0510-0123	FASTENER:PUSH-ON TYPE PILOT LIGHT	78553	C12008-014-4	1	1
0683-2025	R:FXD COMP 2000 OHMS 5% 1/4W	01121	CB 2025	1	1
0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	01121	CB 1011	5	1
0684-1021	R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021	1	1
0684-4721	R:FXD COMP 4700 OHMS 10% 1/4W	01121	CB 4721	4	1
0686-2025	R:FXD COMP 2000 OHMS 5% 1/2W	01121	EB2025	1	1
0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	01121	EB 1011	2	1
0687-1041	R:FXD COMP 100K OHM 10% 1/2W	01121	EB 1041	2	1
0687-1051	R:FXD COMP 1MEGOHM 10% 1/2W	01121	EB 1051	1	1
0687-1241	R:FXD COMP 120K OHMS 10% 1/2W	01121	EB 1241	1	1
0687-1251	R:FXD COMP 1.2MEGOHMS 10% 1/2W	01121	EB 1251	1	1
0687-1511	R:FXD COMP 150 OHMS 10% 1/2W	01121	EB 1511	1	1
0687-1851	R:FXD COMP 1.8MEGOHMS 10% 1/2W	01121	EB 1851	1	1
0687-2211	R:FXD 220 OHMS 10% 1/2W	01121	EB2211	1	1
0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	01121	EB 2231	1	1
0687-2241	R:FXD COMP 220K OHMS 10% 1/2W	01121	EB 2241	1	1
0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	01121	EB 2731	2	1
0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	01121	EB 3311	3	1
0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	01121	EB3331	5	1
0687-4711	R:FXD 470 OHMS 10% 1/2W	01121	EB-4711	1	1

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	01121	EB4721	1	1
0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	01121	EB 4731	1	1
0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	01121	EB 4741	1	1
0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	01121	EB 5621	1	1
0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	01121	EB 5631	2	1
0687-6831	R:FXD 68K OHMS 10% 1/2W	01121	EB-6831	1	1
0687-8211	R:FXD 820 OHMS 10% 1/2W	01121	EB-8211	1	1
0687-8221	R:FXD COMP 8200 OHMS 10% 1/2W	01121	EB 8221	1	1
0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	01121	EB 8231	1	1
0689-3655	R:FXD COMP 3.6MEGOHMS 5% 1W	01121	GB3655	1	1
0690-3931	R:FXD COMP 39K OHMS 10% 1W	01121	GB 3931	1	1
0693-1521	R:FXD COMP 1500 OHMS 10% 2W	01121	HB 1521	1	1
0693-6851	R:FXD COMP 6.8MEGOHMS 10% 2W	01121	HB6851	3	1
0727-0137	R:FXD DEPC 5.18K OHMS 1% 1/2W	19701	DC 1/2CR5	1	1
0727-0393	R:FXD DEP C 4.491K OHM 1/2% 1/2W	19701	CF 1/2	1	1
0727-0394	R:FXD DEP C 499 OHM 1/2% 1/2W	19701	CF 1/2	1	1
0730-0049	R:FXD DEPC 37K OHMS 1% 1W	19701	DC1 R5	1	1
0730-0053	R:FXD DEPC 56K OHMS 1% 1W	19701	DC1 R5	1	1
0730-0153	R:FXD DEPC 17.4K OHMS 1% 1W	19701	DC1 R5	1	1
0758-0006	R:FXD MET FLM 10K OHMS 5% 0.5W	07115	C 20	1	1
0758-0012	R:FXD MET FLM 12K OHMS 5% 1/2W	07115	C 20	1	1
0758-0019	R:FXD MET FLM 18K OHMS 5% 1/2W	07115	C 20	2	1
0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	07115	C 20/22K-5%	4	1
0758-0033	R:FXD MET FLM 2000 OHMS 5% 1/2W	07115	C 20	1	1
0761-0006	R:FXD MET FLM 10K OHM 5% 1W	07115	C 32	1	1
0764-0033	R:FXD MET OX 33 OHM 5% 2W	28480	0764-0033	1	1
0815-0028	R:FXD WW 80 OHM 5%	35434	CHE10-40	1	1
0815-0029	R:FXD 1780 OHM 5%	35434	CHE10-860	1	1
0815-0030	R:FXD WW 1120 OHM CT 5%	35434	CHE10-1120	1	1
0815-0031	R:FXD WW 2400 OHM CT 5%	35434	CHE10-2400	1	1
0816-0015	R:FXD WW 50 OHMS 10% 10W	35434	GC10 50	1	1
0816-0019	R:FXD WW 14 OHMS 10% 10W	35434	TYPE C 10/14	2	1
0836-0003	R:FXD DEPC 29M OHMS 10% 1W	77764	TYPE B8F	1	1
1200-0009	SOCKET:TUBE 7-PIN MINAT	91662	316PH-3702	1	1
1200-0037	SOCKET:CRT TUBE	72825	97094	1	1
1200-0050	PIN:CRT SOCKET	28480	1200-0050	1	1
1200-0086	SOCKET:NUVISTOR 5-PIN	71785	1336510009	1	1
1200-0112	SOCKET:TRANSISTOR	91506	8035-101	1	1
1251-0054	CONNECTOR:FEMALE 24-CONTACT	02660	26-4200-245	2	1
1251-0148	CONNECTOR:POWER	00000	H-10611G-3L	1	1
1251-0202	CONNECTOR:BANANA JACK	83330	221B	3	1
1251-0207	CONNECTOR:PC 20-22 AWG WIRE	00779	42587-5	1	1
1400-0008	HOLDER:FUSE	95915	3510-11	1	1
1400-0123	FUSEHOLDER 3 POLE	75915	35 7003	1	1
1450-0048	LAMP:PILOT NE2H	08717	858R	2	2
1490-0030	STAND:TILT	28480	1490 0030	1	1
1520-0018	MOUNT-VIBRATION	98734	322A	1	1
1850-0062	TRANSISTOR:GERMANIUM	28480	1850 0062	11	11
1850-0064	TRANSISTOR:GERMANIUM 2N1183 PNP	02735	2N1183	1	1
1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	28480	1850-0098	4	4

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

℗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
1850-0143	TRANSISTOR:PNP GERMANIUM	28480	1850-0143	1	1
1851-0017	TRANSISTOR:2N1304	01295	2N1304	3	3
1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	28480	1901 0028	6	6
1901-0032	SEMICON DEVICE: DIODE 1N3209JUNCTION	04713	1N3209	2	2
1902-0009	SEMICON DEVICE: DIODE 1N755 250MW	01281	1N755	2	2
1902-0034	SEMICON DEVICE: DIODE	28480	1902 0034	3	3
1912-0006	SEMICON DEVICE: DIODE GER TUNNEL	28480	1912 0006	1	1
1920-0001	ELECTRON TUBE: 5642	93332	5642	4	4
1921-0013	TUBE:ELECTRON 6CW4	86684	6CW4	1	1
1940-0001	TUBE:ELECTRON 5651	86684	5651	1	1
2100-0095	R:VAR COMP 100K OHMS 30% LIN 1/5W	28480	2100 0095	1	1
2100-0096	R:VAR COMP 1M OHMS 30% LIN 1/5W	28480	2100 0096	2	1
2100-0212	R:VAR COMP 100K OHMS 10% LIN 2W	28480	2100 0212	1	1
2100-0330	R:VAR WW 1500 OHM 10% LIN	28480	2100-0330	1	1
2100-0374	R:VAR COMP 5M OHM 30% LIN 0.5W	28480	2100 0374	1	1
2100-0443	R:VAR 200X3000X7000 OHMS	28480	2100-0443	1	1
2100-0445	R:VAR 2K OHMS 30% LIN	11237	2100-0445	1	1
2100-0756	R:VAR COMP 1.5 MEGOHM	28480	2100-0756	1	1
2110-0004	FUSE:CARTRIDGE 1/4 AMP 250V	75915	3AG/CAT. 312.250	1	10
2110-0006	FUSE:CARTRIDGE 2AMP 125V SLOW BLOW	71400	MDL2	1	1
2110-0012	FUSE:CARTRIDGE 1/2AMP 250V	75915	312500	1	10
2110-0014	FUSE:CARTRIDGE 4 AMP 125V SLOW BLOW	71400	MDX-4	1	10
2110-0033	FUSE: 0.75AMP 250V	79515	F02GR750A	1	10
2140-0008	LAMP:NEON NE2	24455	NE2	1	1
3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	42190	4603	1	1
3101-0030	SWITCH:TOG SPST 15 AMP 125 VAC	04009	82601	1	1
3101-0033	SWITCH:SLIDE DPDT	42190	4633	1	1
3101-0092	SWITCH:PUSHBUTTON DPST NC	82389	975TF	1	1
3160-0026	FAN BLADE:105 120 V, 50-60 CPS	28480	3160 0026	1	1
5000-0747	COVER:SIDE	28480	5000-0747	1	1
5040-0402	MOUNT:HV TRANSFORMER	28480	5040-0402	1	1
5060-0408	COIL-ALIGNMENT	28480	5060-0408	1	1
5060-0736	FRAME:8 X 16 FM CASTING	28480	5060-0736	1	1
5060-0740	TOP COVER ASSY. 16L FM	28480	5060-0740	1	1
5060-0763	HANDLE ASSY-SIDE	28480	5060-0763	1	1
5060-0765	RETAINER-HANDLE ASSY.	28480	5060-0765	1	1
5060-0767	FOOT ASSY-FM	28480	5060-0767	1	1
5060-0777	KIT:RACK MOUNT	28480	5060-0777	1	1
5060-0878	FILTER:AIR	28480	5060-0878	1	1
6960-0016	PLUGBUTTON:NYLON	28480	6960-0016	1	1
6980-0004	TRIM:PLASTIC	00011	CHROME 6A-201(COATED	1	1
8120-0078	CABLE POWER SVT-18-3 7.5FT.	70903	KH4147	1	1
9100-0184	TRANSFORMER:POWER	28480	9100-0184	1	1
9140-0171	COIL-FXD 40UH 10% 1 AMP	78526	H-9897	1	1
9170-0017	CORE:FERRITE	28480	9170-0017	1	1
00140-24701	SUPPORT:TOP PANEL	28480	00140-24701	1	0
00140-24702	SUPPORT:BOTTOM PANEL	28480	00140-24702	1	0

See list of abbreviations in introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire & Cable Company	Redwood City, Calif.
04870	P. M. Motor Co.	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Metro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06136	Ward Leonard Electric	Los Angeles, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U.S. Semcor Div. of Nuclear Corp. of Am.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13396	Telefunken (G.M.B.H.)	Hannover, Germany
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.

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H4-2 DATED: April 1962

00015-31
Revised: June 10, 1963

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
73734	Federal Screw Products Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J. H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Calif.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers,'Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics,	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000TT	Thomas & Betts Co., The	Elizabeth 1, N.J.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S. K. Smith Co.	Los Angeles 45,Calif.

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Revised: June 10, 1963

01638-1

CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from hp, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.

2) Wrap the above in heavy kraft paper.

3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CRT WARRANTY CLAIM

FROM: DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

_____

_____

To process your claim quickly please enter the information indicated below:

1) ℗ INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

_____

_____

_____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure _____

_____

_____

_____

SIGNATURE _____

_____

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your nearest Hewlett-Packard field office for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your nearest Hewlett-Packard field office is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, 94306
U.S.A.
Telephone: (415) 326-3950
TWX No. PAL AL 117-U
Cable: "HEWPACK"

OR (In Western Europe)

Hewlett-Packard S.A.
54 Route Des Acacias
Geneva, Switzerland
Telephone: (022) 42. 81. 50
Cable: "HEWPACKSA"

00140-99001

PRINTED IN U.S.A.

MANUAL CHANGES

MODEL 140A

OSCILLOSCOPE

Manual Serial Prefixed: 326-
Manual Printed: 7/63

Make all changes in this manual according to the Errata below. Also check the following tables for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number	Make Manual Changes	Serial Perfix or Number	Make Manual Changes
407-	1		
413-	1, 2		

ERRATA:

Page 5-7, Table 5-5,
Change first conclusion of step 3 to read: "V301 was bad".
Change schematic (value only) and Table 6-1:
C141, C161: Change to capacitor, fixed, 275 µf, 200 V;
hp Stock No. 0180-0214
Add C318: Capacitor, fixed, 5600 pf, 3 kv VDCW;
hp Stock No. 0160-0384
Add R192: Resistor, fixed, 2000 ohms, 5%, 1/4W;
hp Stock No. 0683-2025
R148: Change to resistor, fixed, 820 ohms, 10%, 1/2W;
hp Stock No. 0687-8211

Note: Some instruments with serial numbers below 326-00275 will have a 330-ohm resistor for R148; resistor 0687-8211 is a preferred replacement.

Table 6-2,
0687-3311: Change TQ to 2
0687-8211: Change TQ to 2

CHANGE 1

Page 6-3, Table 6-1,
Add C1: capacitor, variable, .7-3 pf; hp Stock No. 0132-0003.
Page 5-14, Figure 5-9,
Add variable capacitor C1, .7-3 pf, between pins 12 and 24 of J1.
Page 5-3,
Add paragraph: PLATE CAPACITY ADJUSTMENT after Paragraph 5-17 to read as follows:

a. Install a Model 1402A amplifier plug-in which is known to be properly adjusted.

b. Observe several cycles of a square wave having a rise time of at least 20 nsec. on .5 µsec/cm sweep speed. An hp Model 211A Square Wave Generator may be used.

c. Adjust C1 for optimum response on the top of the square wave.

An alternate method, which can be used if a Model 1402A is not available or if its proper adjustment is in doubt, follows:

a. Disconnect the power cord and isolate the instrument from ground.

b. Install a spare 24 pin connector if available into J1, or install a plug-in with leads unsoldered in plug-in from terminals 12 and 24.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
407-	1		
413-	1, 2		

CHANGE 1 (Cont'd)

c. Using a capacitance meter with a guard voltage available, such as a Tektronix 130 L-C Meter, measure the capacities which make up the equivalent circuit (shown in Figure 1 on this page), being careful to set the meter zero properly before each measurement.

d. Connect the capacitance meter guard voltage to pin 24 and measure the capacity from pin 12 to ground. Let this be capacity C_A.

e. Connect the capacitance meter guard voltage to pin 12 and measure the capacity from pin 24 to ground. This will be capacity C_B.

f. Substitute the values of C_A and C_B obtained above in the following equation and solve for C_C.

$$C_C = 6.75 - \frac{C_A + C_B}{4}$$

g. Connect the guard voltage to the instrument chassis and measure the capacity between pins 12 and 24.

h. Adjust C1 until this capacity equals C_C obtained in step f. The effective capacity as seen by the amplifier output stage will then be 13.5 pf.

i. Resolder any unsoldered leads. If using a Model 1402A, the step response should be checked and appropriate adjustments made in it if necessary.

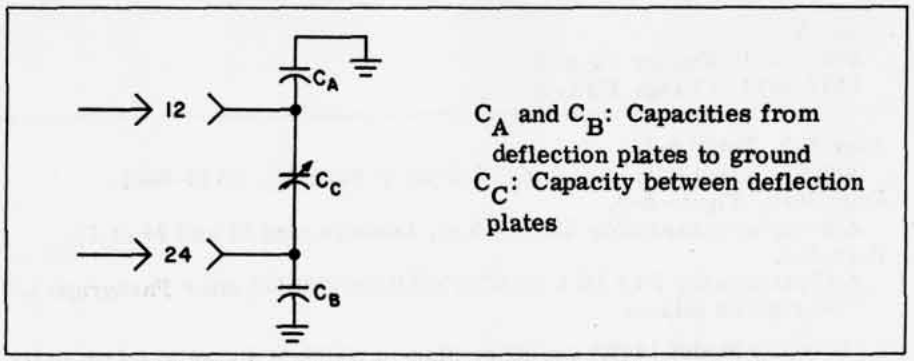


Figure 1. Equivalent Circuit of Capacitance Load

Note

The above adjustment eliminates any need to readjust high-frequency compensation in a wide-band plug-in (such as the Model 1402A) when moving from one Model 140A to another. Adjustment ordinarily is necessary only after replacing CRT.

Table 6-1,

C310, C313, C314, C315, C316, C317, C318: Change to capacitor-fixed .0047 µf, 4 KVDCW; ℗ Stock No. 0160-0151.

R145, R164: Change to resistor-fixed, met film 12K ohms, 5%, 1W; ℗ Stock No. 0761-0028.

Q161, Q163, Q164: Change ℗ Stock No. to 1850-0070.

Q142: Change to transistor 2N708; ℗ Stock No. 1854-0005.

4/9/64

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
407-	1		
413-	1, 2		

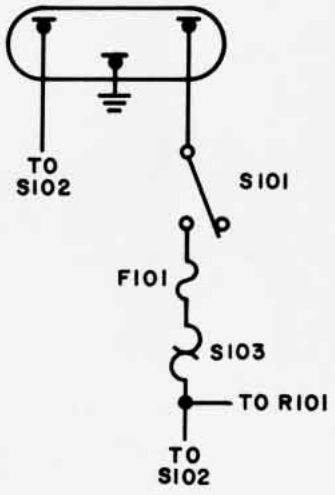
CHANGE 1 (Cont'd)

Table 6-1 and Figure 5-6 (schematic),
C147: Delete.
CR147: Add diode between base and emitter of Q141 (anode connected to base); ℌ Stock No. 1910-0015.
CR125: Add diode between base and emitter of Q121 (anode connected to base; ℌ Stock No. 1910-0015.

CHANGE 2

Table 6-1,
Add Thermal Switch S103; ℌ Stock No. 3103-0009.

Figure 5-6, schematic,
Add Thermal Switch as in the following figure:



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